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## THE OCCURRENCE OF TUCKAHOES AND PORIA COCOS IN FLORIDA

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(WITH PLATE 11 AND 5 TEXT FIGURES)

### INTRODUCTION

During the past several years, numerous growers and farmers in Florida have sent to the Experiment Station various tuckahoes for examination and information. They have been found in widely distributed portions of the state, which would lead one to believe that they are quite at home in the more sandy types of Florida soils. The literature concerning the description and distribution of tuckahoes is somewhat scattered and not easily available.

The description which follows deals wholly with a solid sclerotium of irregular size and shape, which is of various brownish shades, white and granular within, and covered by a crusty, fibrous or scaly, bark-like coat.

Early in 1923, spore-producing structures, developed by artificial means, were observed upon a number of these sclerotia. This paper is designed to make available information concerning the history, description and distribution of the tuckahoe, so far as known at this time.

### HISTORICAL

The earliest writings concerning tuckahoes appeared in a history of the state of Virginia (4), in which there are paragraphs relating to the tuckahoes which the Indians dug out of the ground. Under this term were included a large number of

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terrestrial plant parts, mostly bulbs and roots, referred to as "earth-nuts," "wild onions," "tuberous roots," etc. Certain of these roots were specifically designated as "tuckagoe" and when eaten raw were quite pungent. However, in case of necessity, the Indians managed to make a bread from these tuberous growths. These particular plants grew like the flags in the wet

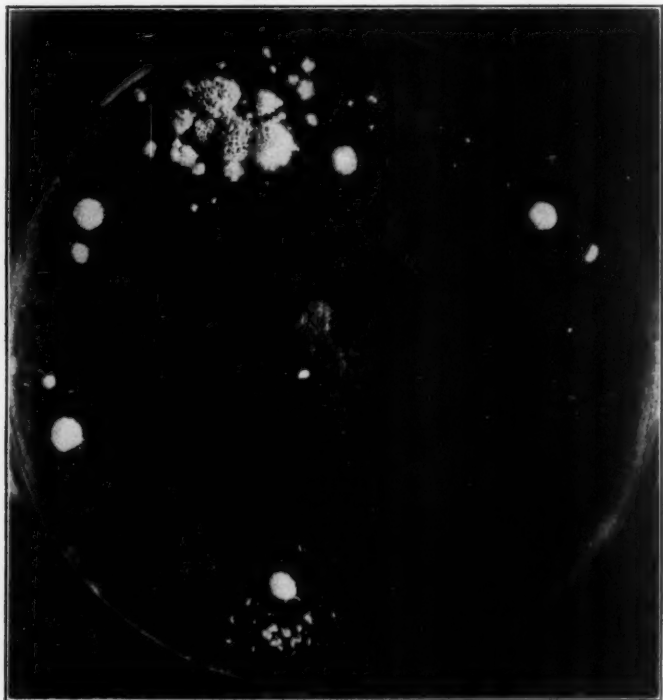


FIG. 1. Fungus in pure culture, planting obtained aseptically from interior of disinfected sclerotium. Fruiting structures developed on potato-dextrose agar in ten days.

marshes and the roots resembled Irish potatoes in size and flavor. Clayton (8) classified certain types of tuckahoes that were apparently of a fungous origin, as *Lycoperdon solidum*, and stated that they were very large tubers of the ground, the outside of which was rough, that they were white within and that the Indians used

them for making bread. Kalm (23) writes that "tawko" or "tawking" was the Indian name for the plant which produced the edible roots. In some places, these roots were known as "tuck-ah" and grew in moist ground or swamps. These descriptive terms probably referred to the common wake-robin, *Arum virginicum*. Another plant commonly found growing in swampy places, namely the golden club, *Aronium aquaticum*, was referred to by the natives by the terms "tawkee," "tawkin," "tockim" and "tockin." These were undoubtedly included under the term "tuckahoe" as found in North Carolina by Beverly (4). These roots grew as large as eight inches in diameter and were cooked in fire-pits. They were somewhat pungent and probably slightly poisonous when fresh. Macbride (26) thought that tuckahoes were the roots of *Erythrina verbacea* or *Convolvulus panduratus*. Smith (39) wrote that the chief root used by the natives was called "tockouhoughe" and that it grew like flags in marshy places and was so plentiful that "a native could gather enough in a day to provide food for a week." These roots resembled potatoes in size and flavor. They were prepared for eating by covering them with wood and firing for twenty-four hours. They were then sliced and dried in the sun and later ground up and mixed with sorrel and meal and used as bread. They were quite bitter when raw and, even when cooked, produced a prickling in the throat when eaten. This astringentness according to Elliott (14) was typical of the tuberous roots of *Convolvulus panduratus* and it may be concluded that this was the plant described above. Torrey (42) made probably the first analysis of the tuckahoe and found that it contained a substance known as "glutin," but was largely composed of a vegetative principle which he designated by the term "sclerotin." It was probably this analysis that prompted Macbride (26) to give it the generic name of "Sclerotium." According to Gore (20), Nuttall listed the tuckahoe by the name of *Lycoperdon sclerotium* and Schweinitz (37) listed it as *Sclerotium Cocos*. Torrey (42) stated that "sclerotin" was identical with "pectous substances" as found by the analysis of Braconnet (5), who analyzed tuckahoes and described the jelly-like substance as "pectose." Johnson (22) related that the tuckahoe was often referred to by the

early settlers as Indian bread and states that the tubers produced no roots or foliage. He also concluded that the roots of certain species of *Convolvulus* were erroneously included under the term tuckahoe. Berkeley (3) described the tuckahoe as a large, tuberous growth found in the southern part of the United States. Also that the fructifications, which he suspected were fungoid in nature, had not been seen. Unger (43) wrote that the tuckahoe was found in the southern states of North America and referred to it as the Indian potato or Indian bread. He mentioned the gigantic *Lycoperdon solidum*, which attained a weight of fifteen to thirty pounds. He also mentioned that it sometimes furnished the entire food for run-away slaves. Gore (20) included tobacco root, *Valeriana edulis*, under the term tuckahoe as used by early writers. Campbell (7) stated that the tuckahoe root was a spontaneous production in the soil. He also pointed out the difference between this tuckahoe and the roots of the plant, *Convolvulus panduratus*. Brown (6), after an analysis of *Sclerotium giganteum*, concluded that it was not of high value as a food. Dodge (12) listed a score of plants, the roots of which have been referred to in one way or another as tuckahoes or Indian bread. He gives in an encyclopedia of chemistry, under the article on "picquotaine," the description of a highly nutritious plant part which was used as food by the Indians and was the result of a disease of the plant *Psoralea esculenta*. Storer (41) stated that the tuckahoe, or Indian bread, was subterranean in its habitat and was sought and eaten by hogs, Indians and natives. Lockwood (25) wrote that the tuckahoe looked somewhat like a baked sweet potato and that the contents were flour-like when dried and ground; otherwise the interior was essentially starchy. Ravenel (34) said that the tuckahoes were usually picked up on plowed ground and were always found when they were full grown and that he had not seen them either in growing condition or partially developed. Banning (2) wrote that the tuckahoes were soft when fresh and coconut-like in appearance, varying in size and shape and that, after two seasons of careful observations, no fruiting forms of the fungus had been found. Fisher (16) presented considerable morphological and chemical analyses and concluded that the sclerotium of *Pachyma Cocos* was

of fungous origin, despite the fact that woody tissue was often present in the younger and smaller sclerotia. Other writers have more or less reviewed the early literature and have connected

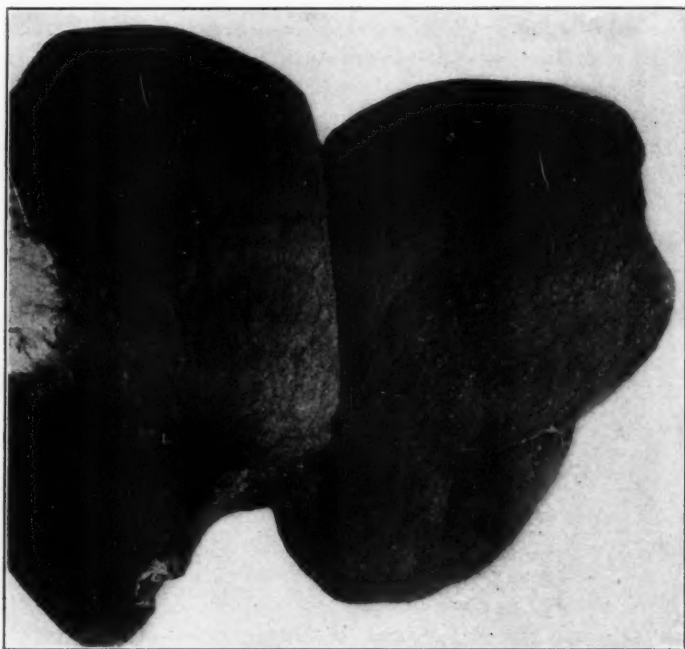


FIG. 2. Sclerotium of *Poria Cocos* (Schw.) Wolf from citrus root.

the tuckahoe, a term used in earlier literature referring to the tuberous roots of higher plants, to the fungus *Pachyma Cocos* as described by Fries (17). The recent developments will be taken up in this paper under separate headings.

#### GEOGRAPHIC DISTRIBUTION

Fries (17), Banning (2), Gore (20), Unger (43), Johnson (22) and Storer (41) report the occurrence of the tuckahoe in pine forests in Delaware, New Jersey, New York, Pennsylvania, Virginia, Maryland, Carolinas, Tennessee, Georgia, Mississippi, Arkansas, Kansas, Texas and Florida. Wolf (46 and 47) ob-

tained 19 specimens from the vicinity of Raleigh, N. C., and later reported 11 additional specimens from the same state. There have been some reports of specimens of this nature other than those found in the United States, namely by Güssow (21) from Canada, by Engler and Prantl (15) from eastern Asia and by Gore (20) from Tasmania and eastern Australia.

The locations where tuckahoes have been found in Florida are as follows: Gainesville, Lake City, Citra, Lake Alfred, Sebring, and Redlands. The largest number found were collected at Citra in 1923.

#### HABITAT

In Florida most of the tuckahoes have been found in the sandy soils. In their distribution in the soil they range from being only slightly covered with sand to several feet deep. Gore (20) stated that light sandy soil or sandy loam not too wet was the best environment for these sclerotia and that none, as far as he knew, were found in old fields or wood lands. Ravenel (34) stated that they were picked up on plowed ground, while Güssow (21) found them in poplar woods. Lockwood (25) found them 18 inches deep in yellow, ferruginous sand and, in this specific instance, encircling a  $\frac{5}{8}$  inch oak tree root. Wolf (46) believed that they are generally distributed over sandy soils of North Carolina through flat-woods, hammock and grove lands, being parasitic and attached to tree roots (usually showing places of attachment) buried in the sand in various depths up to two feet.

#### ECONOMIC IMPORTANCE

From accounts of Banning (2) and Unger (43), it appears that these sclerotia were at times used for food, being roasted and eaten by southern negroes, who had learned of their use from the Indians. Clayton (8) and MacBride (26) stated that they were used in making some sort of bread. Smith (39) wrote that the sclerotia were always roasted, they being usually about the size and shape of potatoes, but were never eaten raw, because they were considered poisonous. Fries (17) stated that they contained certain medicinal properties and were used in this respect by the natives. Rafinesque (33) wrote that tuckahoes were most delicate of all foods, inodorous and of fine taste. Murrill (28)

did not think that they were used much as a source of food and there was no foundation for mere curative virtues from a medicinal standpoint.

#### HOST RANGE

These sclerotia have been reported as associated with the roots of native trees more than any other type of vegetation. Elliott



FIG. 3. Sclerotium of *Poria Cocos* (Schw.) Wolf from *Magnolia* sp.

(13) recorded them on sumac roots, Fries (17) and Schweinitz (38) on pines and Lockwood (25) on the roots of the willow oak, *Quercus phellos*. Maiden (27) and Merrill (28) reported them on eucalyptus roots. Prillieux (32) had always found them associated with pine roots. Wolf (46, 47) found them parasitic on the roots of pine and oak trees and on corn. Stille and Meisch (40) found them on the roots of fir trees and Coker (9) reported them on the roots of cedar. The writer (45) reported them at-

tached to the roots of citrus trees. To date sclerotia have been found in Florida on the roots of magnolia, *Magnolia grandiflora*, grapefruit, *Citrus paradisi*, oak, *Quercus sp.*, sweet orange, *Citrus sinensis*, and eucalyptus, *Eucalyptus sp.*

#### DESCRIPTION

Most of the recent descriptions of the tuckahoe are quite similar and the writers have undoubtedly been talking about a definite type of fungous sclerotia rather than tuberous root growth of higher plants. Gore (20) describes them as being moist and pliable when fresh, tasteless and drying exceedingly hard. The entire sclerotium, except possibly some of the fibers of the outer coat, which resembles the bark of roots, is fungoid in nature. The sclerotia are brown to blackish on the outside and white or pinkish within. Gore's interpretation is that the fungus invades the parenchyma tissue, replaces it, and utilizes the host bark as a natural covering until it is outgrown by the increasing sclerotium, when it is replaced by a wall laid down by the fungus itself. The interior portion is white, granular and spongy and possesses a pronounced fungous odor. Engler and Prantl (15), Schrenck (35), Maiden (27) and Prillieux (32) agree that the white, pliable interior was somewhat granular. Stille and Meisch (40) note an insipid taste to the inner contents, but do not note any odor accompanying the same.

Banning (2) and Lockwood (25) stated that the tuckahoe resembled very much in shape the common cultivated sweet potato. Fries (17) compared the sclerotia to coconuts in their size and shape and external appearance, but stated that they were larger and harder and often varied in shape from spherical to elongate. The sclerotia found in Florida have been of various sizes and shapes. The majority, however, were oblong to subglobose and none of them were elongated as those found and described by Wolf (46). None of the Florida specimens have been more than twice as long as wide. Some of them, however, have been slightly flattened, while others were pointed at one or both ends. The largest found in the state measured 38 inches in circumference the long way round and 25 inches in circumference around the meridian. This specimen weighed 14½ pounds when

fresh and 11 pounds after drying several weeks in the laboratory. The smaller ones were about the size of hen's eggs and more or less irregular in outline. The type described by Wolf (46) was longer than these specimens, one measuring 41 inches long and another one, that was more or less subglobose, measured 27 inches by 19 inches. The largest specimen found by Coker (9) weighed  $22\frac{3}{4}$  pounds. The specimens described by O'Connor (31) weighed  $8\frac{1}{2}$  and  $5\frac{1}{2}$  pounds and were  $8\frac{1}{2}$  inches by 7 inches and 8 inches by  $6\frac{3}{4}$  inches respectively. Maiden (27) described sclerotia that weighed 14, 25 and 39 pounds. Johnson (22) described the size of the sclerotia seen by him as varying from the size of acorns to the size of a man's head. The largest sclerotia seen by Güssow (21) was 22 by 33 inches in circumference. Prillieux (32) and Gore (20) described the cortex as rough, crevassed, scaly, often with fibrous appearance, wrinkled, resembling bark of a tree, somewhat warty, of a brownish-black color, tough and flexible when fresh and drying hard and scale-like. The Florida specimens are very well described by the above, with the possible exception of the small ones, which resemble more closely the bark of trees, the cortex being more or less striated and ridged from end to end. The cortex averages from 3-8 mm. in thickness and is often wrinkled and crevassed, furrowed or grooved, and sometimes quite coarse in texture, especially in the largest specimens, whereas the small ones are often somewhat smooth and more or less warty. The fresh specimens were easily dented by pressure in the hands and, after removal of the pressure, the specimen resumed its previous shape. The outer coat became very coriaceous and hard after the specimens had dried thoroughly. The cortex did not separate readily from the inner portion.

Very little is known about the dissemination of the fungus, but it can readily be supposed that the fungus is spread by the transmission of spores by insects, running water, etc., and that these spores may germinate and infect the roots of plants, thereby growing and reproducing the sclerotia. On the outer coat of a number of sclerotia collected in Florida were found the remains of numerous clusters of weathered and somewhat disintegrated sporophores resembling fruiting structures of a *Poria* (see FIG. 5).

Sporophores produced artificially in pure culture were very similar to the old fruiting structures on the sclerotium. They are probably the same and thus may develop in nature, although fresh fruiting structures have not been observed under natural

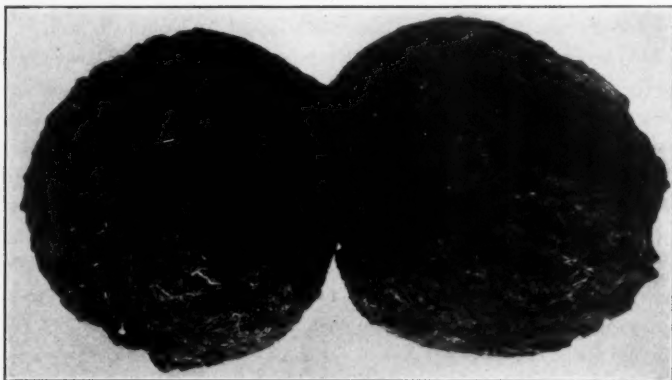


FIG. 4. Sclerotium of *Poria cocos* (Schw.) Wolf from *Eucalyptus* sp.

conditions. The fruiting structures associated with the sclerotia have been observed by a number of writers and, in most cases, have been considered to be of a saprophytic nature. Schrenck (35) was of this opinion and considered the sclerotium as an aggregation of an exudite of plants in the form of an accumulation of gum and gave it the name of gummosis or pectosis. Elliott (13), in making a microscopic examination of the fungus, observed the presence of clamp connections. Wolf (46, 47) considered the sclerotia as a compact mass of fungous tissue in which he found rhizomorphs. In the sclerotia he found in corn stalks, the fungus had invaded the pith of the stalk, replacing the host tissue. The fungus obtained by the writer from plantings of the white inner portion of these sclerotia on poured potato agar plates produced a white, fluffy mycelium in pure culture that grew rapidly over the surface of the medium and there produced the fruiting structures.

#### COMMON NAMES

The term "tuckahoe" is used at the present time, and has been for a number of years, as the name of a certain type of

fungous sclerotium. Most of the early writers used this name in describing tuberous roots of various kinds. The various tribes of Indians used quite similar terms or words in referring to the tuberous roots collectively. Such words as "tuckahoe," "taw-kee," "ptucaui," "petukqui" and "pittikmow" were in common use according to Gore (20). Other Indian words as listed by Kahn (23) are "tawko," "tawking," "tuckah," "tawkee," "tawkin," "tockim" and "tockin" and referred to more or less bulbous, edible roots. The Chinese term "fuh-ling" is recorded by Stille and Meisch (40) as pertaining to edible roots.

The names tuckahoe and Indian bread most frequently appear throughout the early literature and at that time usually referred to all edible roots and almost became generic in their use. They were undoubtedly derived from the group of Indian words for cake or loaf and signified that which is made round and does not refer to the term bread. Consequently, the usual reference for tuckahoe is to all edible tuberous roots, regardless of whether they are phanerogamic or cryptogamic in origin. However, a separation of the cryptogamic plants is necessary in this paper for clarity. The latter will, therefore, be referred to hereafter by the common term sclerotium, the binomial *Pachyma Cocos* (Schw.) Fries, by which the fungus was known for almost a hundred years, or *Poria Cocos* (Schw.) Wolf, by which the fungus is correctly known at the present time.

#### SCIENTIFIC NAMES

Clayton (8) was apparently the first to give a description of the sclerotium and classified it under the name *Lycoperdon solidum*. A few years later, Walter (44) gave it the specific name of *cervinum*. MacBride (26) gave it another name, *Sclerotium giganteum*, followed by Nuttall (Gore 20), who reduced the generic name of *Sclerotium* given by MacBride to specific rank. Thus the fungus became known as *Lycoperdon sclerotium*. Later, Schweinitz (37) listed it with the specific name *Cocos*. Later he, Nuttall (30), thought that it was probably similar to *Sclerotium Cocos* of Schwartz and Schweinitz. Fries (17), in giving a new description of this fungus, stated that it was very different from the genus *Lycoperdon* and placed it in a new genus, *Pachyma*, the word being

derived from the Greek, meaning thick and referring to the thick cortex. He adopted Schweinitz' specific name of *Cocos*, referring to coconuts. The descriptions of this genus and species are in detail and adequately cover the fungus as it is known at the present time. Other names appearing in the literature, according to Gore (20) and Fries (19), are *Pachyma solidum* Oken, *Pachyma pinetorum* Horan, *Pachyma coniferarum* Horan, *Lentinus Tuber regium* Fries and *Agaricus Tuber regium* Fries. Other specimens originating in China are probably synonyms referring to the fungus described herein or a very closely related species. The name *Tuckhaus rugosus* Rafine, which appears in the literature, is probably also a synonym. These above-mentioned names have undoubtedly been applied to the specific fungus under discussion, but the name given by Fries has been carried through the literature in reference to this fungus up until the last few years, when fruiting structures were seen by Wolf (46), who placed it in another genus. He was the first investigator to definitely observe the fruiting stage. Because of its manner of producing spores, he placed it in the genus *Poria*, with the specific name of *Cocos*. Thus, after more than one hundred and fifty years of observation and investigation, this baffling problem was solved.

Other names have appeared in the literature that have referred to organisms that are quite different from the fungus mentioned above. Güssow (21) obtained a number of specimens and was successful after a ten-month period in producing several fruiting structures that were stipitate rather than resupinate and thus quite distinct. He states that they were entirely different from Gore's specimens and described them as a new species by the name of *Grifola Tuckahoe* Güss. The sclerotium of this fungus was dark and there was imbedded in it numerous small stones and considerable sand. It is, therefore, quite different from the somewhat similar form of *Poria Cocos* (Schw.) Wolf. Elliott (13) unsuccessfully attempted to develop the fruiting stage of *Pachyma Cocos*, both on the sclerotia and in culture. Engler and Prantl (15) list a sclerotium from eastern Asia by the name of *Pachyma Hoelen* Rumph., but it is evidently a distinct species. Schroeter (36) concluded that *Mylitta australis*, as listed by Cooke (10), was a sclerotium for which no fruiting stage has been observed, and

was different from *Pachyma Cocos*. Cooke (11) described the fruiting structure of this sclerotium a year later as *Polyporus Mylittae* C. & M. Lloyd (24) stated that *Polyporus Mylittae* Cooke & Massee—a native bread of Australia—and *Polyporus tuberaster* Jacq. were both developed from sclerotia which were similar to the tuckahoes of the southern United States. Careful examination of these sclerotia and fruiting structures and their descriptions was made by Güssow (21) in reference to his species, *Grifola tuckahoe*, and he concluded that they were different, but that they more closely resembled his species than those referred to by Gore (20), namely *Pachyma Cocos* (Schw.) Fries.

Notes in the literature made by a number of different investigators during the time since the tuckahoe was first described have shown that they have been on the lookout for the fructification and in every case they—Berkeley (3), Banning (2), an anonymous writer (1), Engler and Prantl (15) and Schrenck (35)—have stated that it had not been found.

Since Wolf's paper appeared, another by Murrill (28) states that a single sclerotium developed a *Poria*. Weber (45) reported development of a *Poria* on a number of specimens. Coker (9) was later successful in developing the perfect stage on several sclerotia. Thus, with the verification of Wolf's work, there remains no doubt that the fruiting stage of this sclerotium is a *Poria* and that it has been correctly named as *Poria Cocos* (Schw.) Wolf, with the following synonyms:

*Lycoperdon solidum* Clayton, Fl. Virg. 176. 1762.

*Lycoperdon cervinum* Walt. Fl. Carol. 262. 1788.

*Sclerotium giganteum* Macbride, Trans. N. Y. Philos. Soc. 1817.

*Sclerotium Cocos* Schw. Syn. Fung. Carol. Super. 30–31. 1822.

*Pachyma Cocos* (Schw.) Fries, Syst. Myc. 2: 242–243. 1823.

*Pachyma solidum* Oken, Lehrbuch d. Naturg. 2 der Tiel Botanik. 1925.

*Lentinus Tuber regium* Fries, Epic. Syst. Myc. 392. 1836.

*Pachyma pinetorum* Horaninow 2–23. 1856.

*Pachyma coniferarum* Horaninow. 1856.

*Tuckhaus rugosus* Rafine, Med. Fl. N. Am. 2: 255. 1830.

## DEVELOPMENT OF THE PERFECT STAGE IN FLORIDA

During June, 1923, at Citra, Florida, the writer found seven sclerotia (or tuckahoes) attached to the roots of an orange tree. They were regular in shape and weighed from 5 to 9 pounds apiece. The external portion, or cortex, was light brown and

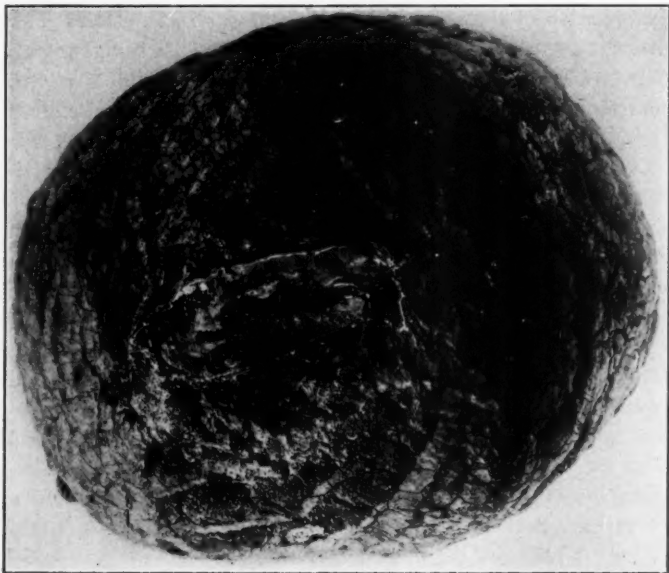


FIG. 5. Sclerotium of *Poria Cocos* (Schw.) Wolf found attached to roots of pine tree, showing place of attachment and series of disintegrated fruiting structures in upper center.

tough, ranging from 3 to 8 mm. in thickness. The interior was white, granular and spongy, having a mushroom (fungous)-like odor. Five of these sclerotia were disinfected in 1:1000 solution of corrosive sublimate for twenty minutes, washed in sterile distilled water, placed in a moist chamber and subjected to intermittent light. At the end of ten days, considerable development of mycelium had taken place and, a day or two later, the first development of the fruiting structures was observed. After twenty days, the fruiting structures were very definitely those of a resupinate *Poria* (PLATE 11). The pores were irregular, 2-4 mm.

in depth, at first creamy-white in color, later changing to a chocolate brown. The basidia and the basidiospores were identical with those described by Wolf. In the meantime, the remaining sclerotia were sterilized on the surface, opened aseptically, and plantings of the white starchy interior were made on poured potato agar plates under aseptic conditions. Fungous mycelium appeared on each of the plates after 36 hours. The fungus completely covered the surface of the agar in the petri dishes in five days at room temperature and at several places in each dish compact masses began to develop. These masses later proved to be the beginning of the development of the fruiting structures. In another week the fruiting structures were mature (FIG. 1), being identical with those developed on the sclerotia in the moist chamber. The appearance and measurement were identical with those in the description of *Poria Cocos* given by Wolf. These cultural methods have been repeated three times with additional sclerotia obtained during the past three years and in each instance the perfect fruiting stage has been developed on one or more of the specimens.

#### QUALITIES AND CONSTITUENTS

Storer (41) stated that the contents of the sclerotia were poor in nitrogen. Prillieux (32) stated that the contents gave no cellulose reaction. Schrenck (35) and Braconnet (5) concluded that the bulk of the inner substance was pectose, the former adding that there was no glutin and that it was largely composed of a substance which he called sclerotin. Torrey (42) stated that this sclerotin was identical with "pectous substances" which he later called pectose. According to Gore (20), chemical analyses have been made of these sclerotia by the University of Virginia, by Storer (41) of the Bussey Institute, and by Brown (6) of the U. S. Department of Agriculture. He concludes that less than 1% of a sclerotium is nutritious, that they show an absence of starch and have very little food value. He also states that he knows of no source having such a high pectin content. The three analyses are shown in the following table:

	U. S. D. A.	Bussey	U. of Va.
Moisture at 110° C.....	12.97	14.57	10.70
Ash.....	.24	.24	3.64
Albuminoides.....	.79	1.38	.78
Carbohydrates.....	79.88	73.73	75.25
Fatty substances.....	.35	.34	—
Crude cellulose.....	5.77	9.80	3.76
Mineral.....			3.64

## SUMMARY

The sclerotia of *Poria Cocos* (Schw.) Wolf occur in Florida, especially in the sandy soils. The fruiting stages were developed in pure culture from portions of the inner contents of the sclerotia removed aseptically and planted on poured agar plates. The pores, basidia and spores, in structure, size, shape, color and content, corresponded well with descriptions given by Wolf. The common and scientific names applied to the sclerotium of this fungus since 1722 are given, with the synonyms listed. The term tuckahoe, formerly applied to all tuberous, terrestrial growth, is suggested for the bulbous rootstalks of phanerogamic plants only. The fungous tubers should be grouped under the term sclerotia, when their fruiting structure is unknown, and classified according to the fructifications they are shown to produce. Weathered and partially disintegrated fruiting structures similar to those artificially developed, resembling a *Poria*, were observed in nature on the cortex of several sclerotia.

The following new hosts of the fungus are reported from Florida: magnolia, *Magnolia grandiflora*; grapefruit, *Citrus paradisi*; sweet orange, *Citrus sinensis*; oak, *Quercus* sp., and eucalyptus, *Eucalyptus* sp. (FIGS. 2-5).

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## EXPLANATION OF PLATE 11

FIG. 1. Fruiting structures developed in moist chamber on sclerotium found attached to orange tree roots. B. Greater magnification showing pore development.

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# AN UNDESCRIBED SPECIES OF MACROPHOMA AND OF VOLUTELLA OCCURRING ON PACHYSANDRA TERMINALIS

W. G. HUTCHINSON

(WITH 4 TEXT FIGURES)

## PART 1

During the latter part of 1925 the attention of the author was directed to diseased specimens of *Pachysandra terminalis* Sieb. and Zucc. received from Yorktown, Virginia. The plants were found to be infected with *Macrophoma* species and *Volutella* species hitherto undescribed.

### THE *Macrophoma* ON *Pachysandra*

The *Macrophoma* produces small black pustules on the dead or partially dried stems. No definite cankers are formed. No hypertrophy or atrophy of the stem is evident.

### Morphology

#### *The Pycnidia:*

The pycnidia are formed singly in the cortical region of the stem. They are globose to ovoid and 200–250  $\mu$  by 150–175  $\mu$ . The pycnidial wall is 5–10  $\mu$  thick.

The pycnidium develops subepidermally from a mass of mycelial threads. The outer layer of the pycnidium is composed of a mass of subhyaline or light brown mycelium and some disintegrating host cells. Within this is a second layer several cells in thickness composed of a dark brown mass of mycelium. This thick dark layer borders upon a narrow layer of subhyaline, pseudo-parenchymatous fungous tissue. The hyaline layer of thin-walled cells bearing the hyaline conidiophores composes the inner layer of the pycnidial wall.

As the pycnidium matures (FIG. 1), the epidermis is ruptured and rolled back and the pycnidia become erumpent, causing the black pustules. The ostiole is very small or entirely wanting.

*The Spores:*

The spores are formed singly on hyaline conidiophores approximately  $10\mu$  long. The spores are one-celled and vary in

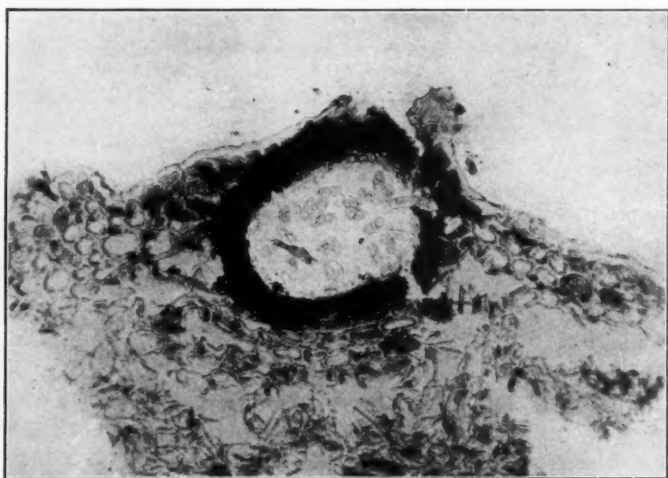


FIG. 1. Photomicrograph of portion of the cross-section of the stem of *Pachysandra terminalis* showing a mature pycnidium of *Macrophoma Pachysandrae*,  $\times 400$ .

color from pure hyaline to an olive or dilute brown. They vary in length from  $11.8$  to  $18.3\mu$  and in width from  $3.9$  to  $9.8\mu$ . The spore wall is from  $1$  to  $2\mu$  thick.

One hundred spores from fresh specimens were accurately measured for length and width. They were mounted in a mounting medium made according to the following formula:

Potassium acetate.....	10 gm.
Distilled water.....	500 c.c.
Erythrosin.....	10 gm.
Glycerine (pure).....	200 c.c.
Ethyl alcohol 95%.....	300 c.c.

Biometrical calculations were made from the measurements and the following constants were derived:

ANALYSIS OF BIOMETRICAL DATA FOR LENGTH OF SPORES OF  
*Macrophoma* ON *Pachysandra*

Standard deviation.....	00.741
Arithmetical mean.....	14.095
Correction.....	00.1525
Mean.....	14.2475
Standard range.....	13.51-14.99 $\mu$

ANALYSIS OF BIOMETRICAL DATA FOR WIDTH OF SPORES OF  
*Macrophoma* ON *Pachysandra*

Standard deviation.....	0.698
Arithmetical mean.....	5.68
Correction.....	0.00
Mean.....	5.68
Standard range.....	4.98-6.38 $\mu$

In about four hours after sowing on a hanging-drop slide the spores germinate readily, usually forming a single germ tube.

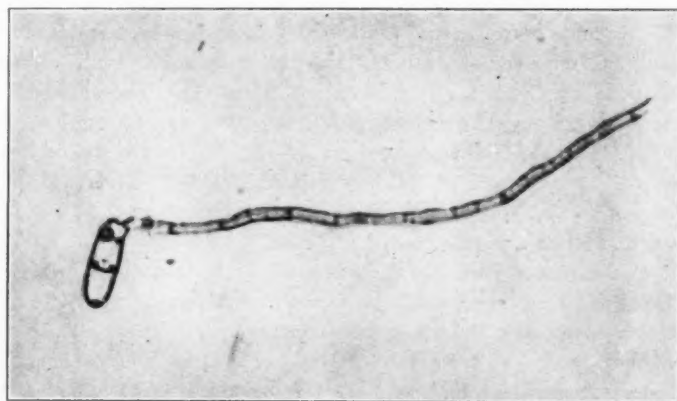


FIG. 2. Photomicrograph of germinating spore of *Macrophoma Pachysandrae* showing the formation of a septum in the spore at the time of germination,  $\times 1350$ .

Immediately preceding germination the spores sometimes develop two large vacuoles and occasionally a septum forms between these (FIG. 2). The usual type of germination is unipolar or bipolar (FIG. 3). Unilateral germination is common and bilateral is very rare.

At 28° C., eighteen hours after sowing, spores showed the following results with regard to the regions of germination:

Unipolar.....	358.....	57.2%
Bipolar.....	162.....	25.9%
Unilateral.....	105.....	16.8%
Bilateral.....	1.....	00.1%

The germ tube continues to grow for some time as a continuous tube with very little branching (FIG. 3, 16). Occasionally a union occurs between the germ tubes of two spores germinating side by side (FIG. 3, 13).

### *Taxonomy*

The pycnidia of this fungus are papillate, separate, smooth, and do not form spots on the leaves. The conidia are one-celled, hyaline, ovoid to oblong, and muticate. All these characters distinguish the fungus as a *Phoma* or a *Macrophoma* (1, 4).

A very unsatisfactory criterion is at present used to distinguish *Phoma* and *Macrophoma*. The fungus having spores over 15  $\mu$  in length is considered a *Macrophoma* and that having spores less than 15  $\mu$  in length is considered a *Phoma* (1). The standard range of the spore lengths of the fungus under consideration is 13.15–14.99  $\mu$ . If this alone is considered, the fungus should be classed as a *Phoma*. Since, however, one spore measured 18.3  $\mu$  in length and several measured slightly over 15  $\mu$ , the fungus might well be classed as a *Macrophoma*.

*Pachysandra terminalis* was introduced into this country from Japan. No reference could be found to any fungus reported on this species. A *Phyllosticta* was found reported (2) on a closely related species, *P. procumbens* Michx. The spore measurements reported were 4.5–6  $\times$  1  $\mu$ . Those for the *Macrophoma* are 11.8–18.3  $\times$  3.9–9.8  $\mu$ . These measurements show that the two fungi could not possibly have been confused.

No *Macrophoma* of corresponding spore measurements could be found reported on any genus among the Buxaceae. A careful search of the literature concerning species of *Macrophoma*, *Phoma*, and *Phyllosticta* occurring on any of the Buxaceae has been made but no similar fungus could be found. It has been definitely concluded, therefore, that this fungus is a new species.

The fungus has been named ***Macrophoma Pachysandrae*** n. sp. It has the following characteristics:

Pycnidiis gregariis, fuscis, globosis-ovoideis, subepidermicis, denique erumpentibus,  $200-250 \times 150-175 \mu$ .

Sporulis oblongis, continuis, hyalinis vel dilute brunneis, non vel 2 guttulis,  $11.8-18.3 \times 3.9-9.8 \mu$ . Basidiis filiformibus, continuis, hyalinis.



FIG. 3. Camera lucida drawings of germinating spores of *Macrophoma Pachysandrae*,  $\times 420$ . Fig 1-13 inclusive show spores four hours after sowing; fig. 14-15 inclusive, eight hours after sowing; fig. 16, ten hours after sowing. Fig. 13 shows two spores the germ tubes of which have united.

*Physiology**The Mycelium:*

The mycelium of *Macrophoma Pachysandrae* is hyaline with a slight suggestion of a brownish pigmentation in the cell wall. In culture the older mycelium en masse has a brown color. The mycelium is found to be intracellular in the cortex and epidermis.

From the inoculations made upon injured and uninjured host tissues it has been found that the mycelium enters the plant not necessarily through wounds but probably through stomata as well.

*Cultures:*

Cultures of *Macrophoma Pachysandrae* were grown on malt, potato, corn meal, and prune agars. On malt agar plentiful mycelium was soon developed but the fruiting bodies were formed in small numbers and very slowly. On corn meal agar the mycelium grew much more slowly and fruiting bodies were formed only after several weeks. On potato and prune agars the mycelium grew very slowly and no fruiting bodies were formed.

The optimum temperature for germination of spores and for growth of mycelium was found to be 28° C.

*Pathogenicity*

The host becomes infected by the fungus through wounds or stomata. The mycelium, after penetration of the host tissue in this manner, extends intracellularly through the cortical and epidermal regions of the stem.

Living, wilted, and dead plants of *Pachysandra terminalis* were inoculated with both spores and mycelium of *Macrophoma Pachysandrae*. On one set of plants to be used for inoculation the epidermis was cut in several places with a sterile scalpel. One series of inoculations was made by spraying the plants with a spore suspension in distilled water. Another series was made by transferring a small amount of agar containing the mycelium to a wound in the stem and covering the area with moist cotton. All the inoculated plants as well as the controls were kept in moist chambers.

After a month's time the plants were examined. The fungus was found to be present only on the dead and nearly dry stems.

The presence of the fungus was not limited to the wounded plants. No results were obtained from the inoculations made with mycelium. The results of the inoculations thus far indicate that the fungus is to be regarded as a saprophyte only.

### *Life History*

The perfect stage of this species of *Macrophoma* has not been determined. The conidial stage is known to occur in the field from June until October. This stage was also obtained in culture and on *Pachysandra* plants in moist chamber throughout the winter at a temperature as low as 10° C. No artificial conditions created in the laboratory brought about the formation of a perfect stage. Under what conditions the perfect stage will form and what this stage is are as yet unknown.

### PART 2

#### THE *Volutella* DISEASE OF *Pachysandra*

This species of *Volutella* has been found to produce a disease only upon *Pachysandra terminalis*. The fungus by cross inoculations has been made to grow upon *Buxus sempervirens* but without causing any definite disease symptoms.

*Pachysandra terminalis* is a widely grown and important nursery plant. Although this disease has not been shown to kill the plants, it does render them very unsightly. This disease can, therefore, be said to be of some economic importance. Up to the present time it has been reported only from Yorktown, Va.

As the specimens were received from the field, the symptoms of the disease were a constriction of the stem and a partial or total browning of the leaves. These symptoms are not always apparent in inoculated material but are found to some extent. The fungus is also found to grow upon browned areas on the leaves of inoculated plants in some few cases.

The mycelium of the fungus lives intracellularly in the epidermis and cortex of the stem. The cortex cells become devoid of chlorophyll. The cells of both cortex and epidermis become more or less shrunken and distorted from a loss of nourishment and water.

## THE CAUSAL ORGANISM

*Morphology**The Sporodochia:*

The sporodochia are seashell pink (3) in color and approximately 5-6 mm. in diameter. They are sessile or rarely stipitate. At the base of the sporodochium arise numerous light brown setae. The setae vary in length from 250 to 450  $\mu$  and in width from 4 to 7  $\mu$ . They are 3- to 7-septate and pointed at the ends. The wall of the seta is approximately 0.5  $\mu$  thick. About 20  $\mu$  from the base of the setae the walls become very thin and the setae gradually taper down to a point.

The formation of the fruiting bodies was studied from cultures only. Here it was found that small tufts of mycelium were formed. These gradually increased in size and were sometimes slightly raised from the surface of the agar by the developing stalks. The setae are usually formed after the sporodochium has matured. Their formation results from the outpushing of modified thick-walled mycelium.

*The Spores:*

The spores are formed in great numbers on long hyaline conidiophores by the pinching off of terminal segments of the conidiophores. The spores vary in length from 2.3 to 6.1  $\mu$  and in width from 0.9 to 2.4  $\mu$ . En masse the spores have a pinkish brown hue although individually they are hyaline. They are filled with granular protoplasm and have a very thin wall.

One hundred spores from fresh material were accurately measured for length and width. The same mounting medium was used as described above. The following constants were obtained:

ANALYSIS OF BIOMETRICAL DATA FOR LENGTH OF SPORES OF  
*Volutella* ON *Pachysandra*

Standard deviation.....	0.65
Arithmetical mean.....	4.57
Correction.....	0.07
Mean.....	4.64
Standard range.....	3.99-5.29 $\mu$

ANALYSIS OF BIOMETRICAL DATA FOR LENGTH OF SPORES OF  
*Volutella* ON *Pachysandra*

Standard deviation.....	0.48
Arithmetical mean.....	1.82
Correction.....	0.00
Mean.....	1.82
Standard range.....	1.34-2.3 $\mu$

From eighteen to twenty hours after sowing on a hanging-drop slide the spores begin to germinate. A large vacuole is usually

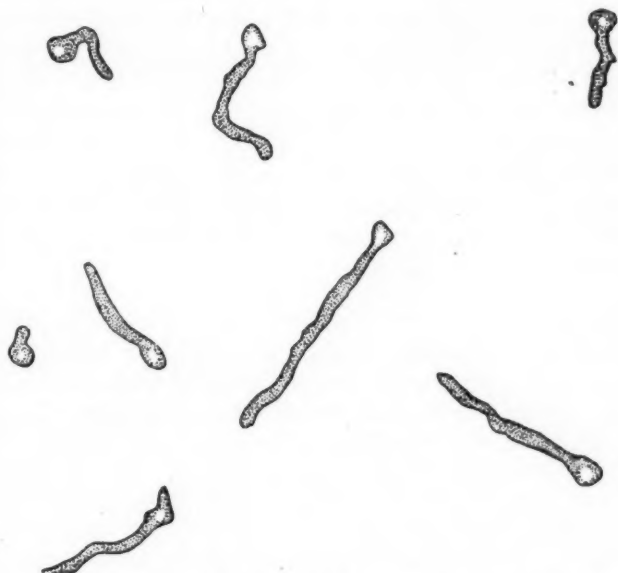


FIG. 4. Camera lucida drawings of germinating spores of *Volutella Pachysandrae*,  $\times 660$

formed previous to the extrusion of the germ tube. The germ tube grows to considerable length before branching and may develop several vacuoles (FIG. 4).

*Taxonomy*

The fact that the fruiting body takes the form of a globose-sessile sporodochium places the fungus among the Tuber, culariaceae. The sporodochia have numerous setae at the margin

and the spores are one-celled and hyaline. The fungus should, therefore, be classed as a *Volutella*.

A careful search of the literature concerning the *Volutellas* occurring on any genus among the Buxaceae has been made. None has been found corresponding in every detail to this fungus. It has been concluded, therefore, that this fungus is a new species.

The fungus has been named *Volutella Pachysandrae* n. sp. It has the following characteristics:

Sporodochiis gregariis, sessilis vel stipitatis, globosis, hyalinis-roseis, minutis 5-6 mm. in dia.; setis brunneis-hyalinis, 3-7 septatis,  $250-450 \times 4-7 \mu$ .

Conidiis hyalinis, continuis, oblongis,  $2.3-6.1 \times 0.9-2.4 \mu$ .

#### *Physiology*

##### *The Mycelium:*

The hyaline to light brown mycelium gains entrance to the host tissues through stomata or wounds and lives intracellularly in the epidermis and cortex. It is profusely branched and contains numerous vacuoles.

##### *Cultures:*

*Volutella Pachysandrae* grows and fruits most readily upon potato agar. Fruiting bodies and profuse mycelium are formed in two or three days. Interesting color reactions were observed in these cultures. Especially at the edge of the colonies the mycelium became a Corinthian purple (3). The developing fruiting bodies varied in color from white to light buff, cream color, and seashell pink (3).

On corn meal agar this fungus forms fruiting bodies in two or three days but there is very slight growth of mycelium. On prune agar and malt agar the mycelium grows readily but fruiting bodies are formed very slowly.

The optimum temperature for spore germination and for growth of mycelium was found to be 28° C.

#### *Pathogenicity*

The fungus gains entrance to the host through the stomata and especially through wounds. The mycelium lives within the cells of the epidermis and cortex.

Several sets of inoculations were made upon living, wilted, and dead plants. These inoculations were made by spraying with a spore suspension in distilled water and the plants were then placed in moist chambers. On some of the plants the leaves and stems were bruised and cut with a sterile scalpel before inoculations were made.

After two weeks the plants were examined. Those which were dead or wilted, both injured and uninjured, were found to be infected. The living plants were in most cases healthy. Fruiting bodies were present, however, on some of the living plants which had been cut or bruised. On one of these a characteristic constriction was formed which encircled the stem. On the constriction and the area adjacent to it were found numerous fruiting bodies of the *Volutella*. Irregularly defined brown areas developed on some of the bruised leaves. Numerous fruiting bodies of the *Volutella* were produced in the region of the wound. Cultures of *V. Pachysandrae* were obtained from the inoculated plants.

The results of the inoculations show that the fungus is parasitic to some extent. It does not develop on a normal living plant but will develop if the plant becomes weakened or wounded in any way. It may well be considered a wound parasite.

A series of cross inoculations were made with this fungus and *Volutella Buxi* Berk. upon *Pachysandra terminalis* and *Buxus sempervirens*. It was found that *V. Pachysandrae* would fruit upon the dead or dry leaves of *Buxus* but produced no disease symptoms. *V. Buxi* also fruited upon the dry leaves and stems of *Pachysandra* but produced no symptoms of disease.

#### *Life History*

The perfect stage of this *Volutella* has not as yet been determined. The conidial stage has been found in the field from June to October. In the laboratory the conidial stage only has developed throughout the winter in culture and on the inoculated plants.

#### *Summary*

*Macrophoma Pachysandrae* n. sp. has been found on *Pachysandra terminalis*, causing black pustules but no definite cankers on the dead or partially dried stems.

The pycnidia are globose to ovoid,  $200\text{--}250 \times 150\text{--}175 \mu$ , and are formed singly in the epidermis and cortex of the stem.

The hyaline to light brown spores are formed on short hyaline conidiophores. The spore measurements are  $11.8\text{--}18.3 \times 3.9\text{--}9.8 \mu$ . The standard range is  $13.51\text{--}14.99 \times 4.98\text{--}6.38 \mu$ . During germination the spores usually send out a germ tube at one or both ends. A septum sometimes forms in the germinating spore. The optimum temperature for spore germination is  $28^\circ \text{C}$ .

The mycelium lives intracellularly in the cortex and epidermis. The optimum temperature for growth of the mycelium is  $28^\circ \text{C}$ . The best growth is obtained on malt agar.

The fungus enters the host through stomata or wounds. Inoculations thus far indicate that the fungus is a saprophyte.

The perfect stage has not been determined.

*Volutella Pachysandrae* produces a diseased condition in the stems and sometimes in the leaves of *Pachysandra terminalis*. A constriction is formed on the stem. Irregular browned areas appear on the leaves.

The sessile to stipitate sporodochia are seashell pink in color and average 5–6 mm. in diameter. The setae measure  $250\text{--}450 \times 4\text{--}7 \mu$  and are 3- to 7-septate.

The spores are hyaline and single-celled. They measure  $2.3\text{--}6.1 \times 0.9\text{--}2.4 \mu$ . The standard range is  $3.99\text{--}5.29 \times 1.34\text{--}2.3 \mu$ . A large vacuole is usually formed at the time of germination.  $28^\circ \text{C}$ . is the optimum temperature for spore germination.

The mycelium is intracellular.  $28^\circ \text{C}$ . is the optimum temperature for growth of the mycelium. The fungus shows the best and most rapid growth on potato agar.

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## AN ANCIENT ROMAN TOADSTOOL CARVED IN STONE

JOHN W. HARSHBERGER

(WITH 1 TEXT FIGURE)

About 100 A.D., the Roman emperor, Trajan, ordered the legate, P. Munatius Gallus, commander of the Third Legion, to found the City of Thamugadi (Timgad) at the foot of the Aures mountains in eastern Algeria, as the outpost of Roman power in North Africa to guard the empire against the native Berber tribes (Barbarians). The town saw its prime in the second half of the Second and in the Third Century, passing later through trying vicissitudes until it was destroyed and burned by the hostile Berber tribes of the Aures mountains in 534 A.D. It was finally abandoned at the close of the Byzantine domination, and the ruins were gradually buried under the desert sands and outwash from the mountains with the exception of Trajan's arch, and the entombed town remained in almost complete oblivion for twelve centuries until the French government in 1880 began the excavation of the ruins. The city has now been practically uncovered and the visitor is shown the theater, the library, the hot and cold baths, the capitol, Trajan's arch and the market places.

The writer on a visit to the forest of Atlas cedar at the Col de Telfet, west of Batna, Algeria, made an automobile trip across the desert from Batna to Timgad, thirty-seven kilometers away, on July 22, 1928. The ruins at Timgad were found to possess great interest as showing the advanced architectural and engineering skill of the ancient Romans. Here in the chief market place, which was originally surrounded by colonnades, were found two large blocks of stone, which had been carved to form part of the architectural decorations of the colonnades. One large block had been decorated with a scroll of grape vines with bunches of grapes. The other one was characterized by a design of *Acanthus* leaves surrounding a centrally placed stone toadstool (Fig. 1), carved so that the gills and related stipe with basal

volva are clearly shown. The stone figure has been identified as a toadstool, although with its volva, it probably represents some poisonous, pileate, lamellate, fleshy toadstool known to the ancient



FIG. 1. Ancient toadstool carving

artist, who designed the architectural ornamentation of the Timgad market place. Do we not have in this stone carving the earliest known representation of a fleshy, gill-bearing fungus, dating back to the second century A.D.?

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## NOTES ON THE HYDNACEAE<sup>1</sup>

HOWARD J. BANKER

Some years ago the writer published a series of papers (3) which were intended as a preliminary study to a monographic treatment of the family of the Hydnaceae. That work was interrupted by a change of location necessitating a hasty packing of all herbarium material and notes as was supposed for only a few months but years have passed and only recently has it been possible to again have access to this material. In this period circumstances have so changed that it is improbable that the work can ever be continued as first planned. It has seemed, therefore, desirable to place on record in this more informal way the results of some of these studies which had been made yet are not in all respects ready for publication.

The resupinate Hydnaceae are very difficult to deal with on their own account and especially so in view of the prevailing taxonomic treatment. A multitude of species have been inadequately described and have been discriminated one from the other by what seem to the writer as extremely superficial and inconstant characters. The so-called "B. & C." species have especially added to the difficulties of properly segregating our American forms. The study of the original collections gives little aid in clarifying the situation so long as one's mind is under the incubus of the older taxonomic conceptions. I believe that the Friesian taxonomy itself in respect to these forms must be radically revised before we can find a natural basis for the discrimination of the species.

The great bulk of the resupinates are commonly described under the generic name of *Hydnum* as a convenient catch-all having scarcely more than a family significance. As the writer has restricted that term to a group of fleshy pileate forms of which the type is *Hydnum repandum* L. (2, p. 104), to be self-consistent he is under the necessity of assigning to the resupinate forms some

<sup>1</sup> Investigation prosecuted with the aid of a grant from the Esther Herrman Research Fund of the New York Academy of Science.

other generic name or names. His studies, however, have not proceeded far enough to warrant ascribing a definite generic status to most of the species or to decide in all cases what older names must be retained under a new system. In fact, specific limitations are in many cases ill defined and hazy. Some fundamental questions apparently can be settled only by cultural studies.

After separating out a few fairly well-marked genera, the remaining resupinates seem to fall chiefly into two groups characterized, on the one hand, by a sub-gelatinous to waxy consistency of the mycelial substance and, on the other, by a dry, compact to floccose mycelium. That one or more genera may be further segregated from these forms on the basis of constant hyphal and spore characters seems possible but can not be definitely asserted by the writer.

What names may be applied to these groups must first depend on which of the older generic types are included in each segregation, a problem that is far from easy of solution. It seems possible that the Friesian name *Grandinia* should be retained for one of the above described groups by emphasizing the character *ceraceum* rather than *granulosum* in Fries's original description of the genus (5, p. 527). It is to be noted that in his descriptions of the seven species under this genus Fries mentions, as the first named characteristic of the first five species, "ceracea" or "sub-ceracea." Yet it is probable that he was prone to recognize the genus himself by the more superficial character of the granulose hymenium and certainly that has been the prevailing conception in all later work. The writer, however, believes that the nature of the substance is a more natural character.

One genus which we feel fairly confident may be segregated from these resupinate forms as based on well-defined and fundamental characters is *Odontia* of Persoon, not *Odontia* of Fries. For the latter we have long since suggested the name *Eltheiroduon* (1, p. 441) but we are not now satisfied that the genus is of good standing, at least in its prevailing conception as primarily characterized by crested or penicillate verrucae or warts. If, however, we should revert to the Friesian emphasis, "*Resupinato-effusae, aridae nec ut praecedentes*" [*Grandinia*] "*ceraceae*" (5, p. 528), in

our conceptions of its fundamental character, it might be found to be an available name for more or less of the forms described above as having a "dry, compact to floccose substance." As to the *Odontia* of Persoon there appears to be no question of its validity although it is probable that its author would hardly recognize his genus under our definition. However that may be, by chance or otherwise, he established the genus, according to our modern rules, on a form which we now know to be quite distinct from the usual run of resupinate hydnums and wholly removed from the *Odontia* of Fries. In this greatly restricted sense we may accept *Odontia* Persoon as a valid genus.

ODONTIA Pers. Neues Mag. Bot. 1: 110. 1794

The genus *Odontia* Pers. was established on *Odontia ferruginea* and *O. nivea*. The first named species must be considered the type of the genus. Later Persoon discarded the genus *Odontia*, referring the species as a subgenus to the older genus, *Hydnum* (7, p. 560). It is evident that Persoon intended his genus *Odontia* to include the resupinate forms segregated from the genus *Hydnum*.

In 1815 Fries took up the name *Odontia* as a subgenus of *Hydnum* (4, p. 149) probably in the Persoonian sense, but in 1836-38 (5, p. 528) he published the name as a genus in a greatly restricted sense that wholly excluded the original species on which Persoon founded his genus and even excluded the species which he had himself included in his former subgenus *Odontia*. In this more specialized Friesian use the genus has ever since been understood.

The Persoonian conception seems to us too broad but in restricting the scope of the genus it is evident that the name should be retained for that segregation which includes *Odontia ferruginea* Pers. So far as our understanding of the species is concerned the genus appears to be monotypic, and may be characterized as follows: Plants resupinate-effused; subiculum dry, tomentose, dark colored; spores ovoid to globose, tuberculate, fuscous; hyphae thick walled, colored. The genus is very near *Hydnellum* Karst., from which it differs chiefly in being wholly resupinate and effused.

ODONTIA FERRUGINEA Pers. Neues Mag. Bot. 1: 110. 1794

*Hydnum tomentosum* Schrad. Spic. 177. pl. 4. f. 2. 1794; not *H. tomentosum* L. Sp. Pl. 2: 1178. 1753.

*Hydnum ferruginosum* Fries, Syst. Myc. 1: 416. 1821.

*Hydnum crinale* Fries, Epic. Syst. Myc. 516. 1836-38.

No type specimen of *Odontia ferruginea* Pers. was to be found at Leyden. The species, however, is so very distinct from other resupinate forms of the Hydnaceae that there has never been any doubt expressed as to its identity. The synonymy has arisen chiefly from other causes.

*Hydnum tomentosum* Schrad. was described in the same year as *Odontia ferruginea* Pers. and there might be some question as to priority of name but for the fact that Schrader's name is untenable, having been previously used by Linnaeus for a distinctly stipitate form.<sup>2</sup> So far as the writer knows there is no type specimen of Schrader's species but his very full and exact description applies perfectly to the plants which we consider to be typical of *O. ferruginea* Pers. and to no other. We have not seen Schrader's figure as the copy of the Spicelegium to which we have had access lacked the plate. The citations of Fries and other authors also confirm our belief that the two species are identical.

*Hydnum ferruginosum* Fries was understood by Fries to be the same as *H. tomentosum* Schrad. and *O. ferruginea* Pers. His description in part is very nearly verbatim from Schrader and both Schrader's and Persoon's names are cited as synonyms. As Schrader's name was already used for a Linnaean species recognized by Fries and as Fries had used the name *ferrugineum* for a stipitate species of his own,<sup>3</sup> he discarded both names and coined one of his own. As this is in violation of the law of priority, we would restore the Persoonian name.

There was no type specimen of *Hydnum ferruginosum* Fries at Upsala. A specimen collected by Karsten in 1864 was placed under this name, but was clearly *Asterodon ferruginosum* Pat., as was noted on the sheet in manuscript notes by Bresadola. We have little reason to suppose that this specimen represents the *H. ferruginosum* of Fries although its color is much more sugges-

<sup>2</sup> See MYCOLOGIA 5: 64. 1913.

<sup>3</sup> See MYCOLOGIA 5: 197. 1913.

tive of Fries's later description, "fulvo-ferrugineis" (5, p. 516) than are the plants which we refer to *O. ferruginea* Pers.

*Hydnum crinale* Fries was represented at Upsala by a specimen that appeared to be identical in every respect, including spore characters, with the plants which we consider to be *O. ferruginea* Pers. We can not be sure that this specimen is the type of the species. The descriptions of *H. crinale* and of *H. ferruginosum* as given in the *Epicrisis* and repeated in Fries's later work, "Hymenomycetes Europaei" (6, p. 613), seem to apply to our specimens the one about as well as the other and neither is wholly accurate. Thus the expression "aculeisque umbrinis unicoloribus" used of *H. crinale* describes the color in our plants much more closely than does the expression "fulvo-ferrugineis" used of *H. ferruginosum*, while on the other hand the terms "aculeisque confertis conico-subulatis acutis," used in respect to *H. ferruginosum*, is more applicable to our plants than the phrase "aculeisque longis gracillimis" used for *H. crinale*. Yet it is only in these particulars that the two descriptions materially differ.

Another species, first described as: *Grandinia coriaria* Peck, Bull. Buffalo Soc. Nat. Sci. 1: 61. 1873,<sup>4</sup> may perhaps be referred to this genus if Peck's interpretation was correct. I have never been able satisfactorily to demonstrate basidia in specimens commonly referred to this species. It seems possible that it does not belong to the Basidiomycetes at all and may be one of the Dematiaceae of the Fungi Imperfecti. This is quite beyond the range of my studies but shows to what lengths we may be led when guided only by gross superficial characters.

I have not been satisfied that *Grandinia coriaria* Peck is distinct from

*Grandinia tabacina* Cooke & Ellis, Grevillea 9: 103. 1881.

*Zygodesmus granulosus* Peck, Bot. Gaz. 6: 277. 1881.

<sup>4</sup> Saccardo (Syll. Fung. 6: 503) cites for the species "Peck 26 Rep. p. 71," that is, "Report of the Botanist from the Twenty-sixth Annual Report on the New York State Museum of Natural History, for the year 1872." The fact is the Botanist's report was not issued until April, 1874, even then "in advance of the report," as stated on the separate. In the meantime Dr. Peck had described the species in July, 1873, as cited in the text above.

*Zygodesmus rubiginosus* Peck, Ann. Rept. N. Y. State Mus. 30: 58. 1879.

*Zygodesmus hydnoides* Berk. & Curt. Grev. 3: 112. 1875.

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## AN EASY METHOD FOR THE STUDY OF SIMPLE HYPHALES IN CULTURES<sup>1</sup>

R. CIFERRI

(WITH 2 TEXT FIGURES)

For several years I have been employing an easy method for the study of the morphological characteristics of Mucedineae, Dematiaceae and "Mycelia sterilia" in cultures, which has given me excellent results and to which I refer as follows. \*

Said method is, in part, a perfection of the well-known drop culture of van Tieghem and Le Monnier, and, in part, of the Unna method, of dry culture.<sup>2</sup> It has the advantage over the first one in that it is much easier, it does not produce contractions in the hyphae when it dries, and it does not alter in the least the form and disposition of the different organs. The minimum care required for an ordinary agar or gelatine culture is sufficient to guarantee against any contamination, which is not true of the drop culture method; the process of fixation, staining, mounting, etc., does not alter the position of the organs, and the mycological materials solidly attached to the cover glass are not wasted in the immersions and manipulations.

It has the advantage over the Unna method (or the "lames sèches" method of Beurmann and Gougerot) of allowing a much more ample development on the surface, and, later, securing more satisfactory results by allowing the use of solid nutrient media as desired, results difficult to obtain with the Unna method.

I must say that not all the Hyphales are equally adapted for cultivations by this method; those with aggregated fructifications, such as the Tuberculariaceae and the Stilbaceae, the simple Hyphales with erect fructification being less suited to this method, and on the other hand it is especially adapted to the

<sup>1</sup> Contributions of the National Agronomic Station of Moca, N. 54.

<sup>2</sup> For bibliographical references and description of methods, see Langeron, Précis de Microscopie, XVI, 1034, IVe Ed., Paris.

study of fungi whose development is principally mycelial, or whose fructifications are almost entirely mycelial. This method serves very well for the morphological and morphogenic study of

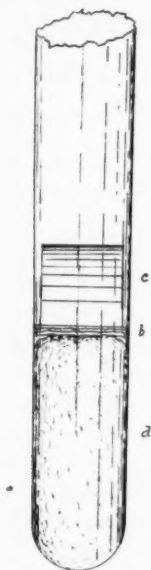


FIG. 1. Representation of the lower portion of culture tube with the cover glass. *a*, layer of raw cotton; *b*, triple layer of filter paper; *c*, cover glass. (Reduced.)

the pathogenic group of Dermatophyose fungi (Dermatophytae or Dermatophycetae) whose study by the ordinary method is frequently difficult.

In general, the method consists in making the fungus develop on a very thin layer of solid nutrient media in a moist chamber (so as to avoid the evaporation that would very rapidly dry the culture media) on a cover glass. For this purpose, cover glasses of the desired form are chosen, taking into consideration that up to a certain limit it is convenient to increase the size for the culture in tubes; and furthermore these culture tubes should be changed for Petri dishes as advised later.

Generally, squared glasses 20 mm. or less, because of the difficulty of finding culture tubes of a larger diameter, are employed.

The difference between the diameter of the tube and the size of the cover glass must be such as to permit the easy entrance into the tube, leaving same inclined (FIG. 1). For example, for tubes of 20 mm. in diameter, use cover glasses  $18 \times 18$  mm. These cover glasses must be very clean, since a thin layer of grease would prevent the complete adherence of the nutrient medium. It is advisable then to wash them the last time with sulphuric ether. Then take culture tubes and put on the waxed extreme of the tube a plug of raw cotton about 30 mm. high, compressing lightly, and above place two or three disks of filter paper. In each tube place a clean glass, plug it as usual with cotton and sterilize all with dry heat. The tubes thus prepared are preserved together with the sterile material in accordance with mycological technic. Figure 1 represents the lower portion of the tube thus prepared.

When one wishes to prepare cover glasses for culture (attention is called to the fact that it is better for same to be recently prepared), a tube containing the agar or gelatine required is dissolved and the contents of a Petri dish maintained at  $60^{\circ}$ – $70^{\circ}$  C. is poured; then put away the sterile glasses, warm them rapidly over a flame and make them float in the melted nutritive medium. In the tube, enough of distilled water is used to thoroughly wet the cotton and the filter paper. The cover glasses are taken with forceps and placed inside the tube until they are settled on the filter paper. The tubes thus prepared will be sterilized in the auto-clave and, if the nutritive medium is sufficiently fluid and the cover glasses hot, the excess medium that is strained on the filter paper will be insignificant; but if the results are contrary, no harm is done.

When the tubes are cooled, the fungus is transplanted on the surface that was wet with the agar or gelatine; the same is covered as usual, with a cotton cork and a rubber hood sterilized with mercury bichloride.

The fungus will develop on the surface of the glass; when the development is finished, uncover the tube and take out the cover glass. Generally for agar culture, the fungus can be fixed with alcohol; in certain cases, especially for culture on soft gelatine, the nutrient medium can be hardened with formaldehyde steam.

In the same manner, any cytological fixative can be employed; the cover glass thus prepared can be treated as desired. Usually the process is completed by dehydrating and mounting the object with Canada Balsam on a slide. In this case, there should



FIG. 2. Representation of the mounting of a cover glass with the fungus culture. *a*, slide; *b*, Canada balsam for the adhesion of the two glasses; *c*, cover glass with the fungus; *d*, Canada balsam interposed between the two cover glasses; *e*, cover glass for mounting. (Natural size.)

be interposed between the fungus and the upper surface of the cover glass a very thin layer of nutritive medium; but usually this is unnecessary. In case one wishes to make very careful observations as to cytological details, it is convenient to employ the mounting system drawn on FIGURE 2. On the slide is placed the dehydrated and stained cover glass with the fungus, interposing a drop of Canada Balsam between the slide and the free surface of the same, so that the surface with the fungus remains on the upper side. A second drop of Balsam is placed on the surface of the cover glass with the fungus and a second cover glass is placed on top of the first one.

For culture on large cover glasses, instead of culture tubes, there should be placed one or more of these on disks of wet filter paper in a Petri dish. In sterilization in the autoclave, the dishes must be inclined so as to drain off the possible excess of the nutrient medium from the cover glasses. This second method is not so satisfactory as the first one.

It is not advisable to use in the fungus nutrient media which form crystals that may interfere with the microscopical study. With certain biological stains, the culture media are lightly stained but generally this does not bother the microscopist.

If one wishes to keep the cover glasses with the fungus cultures unmounted, it can be fixed with alcohol, formaldehyde, or any other fixative, dried and put in melted paraffine. When desiring to use same, the paraffine may be dissolved with xylol and the cover glasses will be ready for final treatments.

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## TABULATION OF ALTERNARIA AND MACROSPORIUM<sup>1</sup>

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Incomplete descriptions, mutations, secondary development of spores, dwarfing of spores in culture, and facultative parasitism resulting in large host ranges have caused great confusion in the classification of the species of *Alternaria* and *Macrosporium*.

This tabulation was compiled to make possible the classification of the species of these fungi used in inoculations (Young, 33). The species in the table are arranged on the basis of minimum spore lengths.

The columns of family names and translated generic names serve as a convenient index to the plants bearing these fungi.

Monographic work of sufficient completeness, including pathological and physiological studies, will probably reduce to synonymy many specific names of *Alternaria* and *Macrosporium*. *Alternaria tenuis* Nees and *Macrosporium commune* Rabh. are difficult to separate. Elliott (10) placed the species of *Alternaria* in seven main morphological groups, and said that echinulation is not a constant character. He and Young (33) demonstrated the wide host ranges of these fungi in the laboratory and the greenhouse. Elliott clearly showed that the generic name *Macrosporium* should be abandoned because all the species of *Macrosporium* belong in *Alternaria* or *Stemphylium* because they have catenulate, sarcinaeform, or globose conidia. There is a laudable tendency to follow his emended description of *Alternaria*. *Macrosporium* is used here only because so many species were described under this name.

Before *Alternaria* is monographed, its species will continue to be classified on the useful bases of spore sizes and food plants.

<sup>1</sup> Published with the approval of the Director of the Montana Agricultural Experiment Station. Thanks are due to Dr. W. G. Solheim of the Botany Dept. at the University of Illinois for aid in library work, and to Professors H. E. Morris and D. B. Swingle of the Montana Agricultural Experiment Station for criticizing the manuscript.

Now it is extremely difficult to classify these fungi because most of the specific descriptions are very incomplete. Roberts (24), Milbraith (15) and Rands (22) are among those who have written the few adequate descriptions. Plunkett (20) and Bonde (2) report mutations in species of *Alternaria*.

Young (33) measured the spores of many species and grew them in culture.<sup>2</sup> These measurements, given here for the first time as citation 34, are based on both natural habitat and laboratory characters. They add to the list of host plants, and show that ranges of spore measurements are too small as given in the specific descriptions. The cultures supported the statement by Elliott (10) that *Alternaria* spores produced on culture media tend to be smaller than spores borne on their natural food plants.

Elliott (10) gave spore measurements of some species in his graphs; they are included in the table. Bolle (1) contributed to the knowledge of *Alternaria*.

The following species of *Alternaria* and *Macrosporium* (listed according to their reference numbers) were given descriptions so incomplete in the "Sylloge Fungorum" that they are practically useless: Vol. 4: species numbers 2M, 7M, 16M, 25M, 38M, 39M, 40M, 44M, 49M, 51M, 67M, 72M, 76M, 5A, and 6A. Vol. 10: numbers 2M, 13M, 18M, 24M, and 4A. Vol. 14: species number 8M. Vol. 16: numbers 3A and 4A. Vol. 18: numbers 5M, 7A, and 8A. Vol. 22: numbers 8M, 11M, 13M, 14M, 15M, 16M, 1A, and 7A. Since sizes of conidia were not given in the descriptions, these species could not be tabulated here.

#### TRANSLATION OF GENERIC NAMES INFLECTED IN LATIN

The deplorable custom of inflecting generic names in Latin descriptions has caused considerable bewilderment by altering many names so much that recognition is difficult and often doubtful. In these numerous cases the reader loses much time in determining the nominative singular forms of the inflected generic names. As examples, what are the translations of the following cases? (a) Genitive: *Cucumeris*, *Diptericis*, *Crotonis*, *Smilacis*, *Gyrinopseos*, *Dryadis*, *Dolichi*, *Ammi*, *Praedanthi*,

<sup>2</sup> The fungi were grown at 25° C. on agar prepared as follows: 50 g. of white corn meal were cooked in one liter of water for one hour, and then filtered. The filtrate was cooked with 13 g. of agar for 1.5 hr. at 100° C., and then centrifuged.

*Iunci*, *Sporotrichi*, *Phasiani*, etc. (b) Accusative: *Typham*, *Agaricum*, etc. (c) Ablative: *Fumagine*, *Dichaena*, *Allio*, etc. (d) Adjectival forms: *quercino*, *abietinis*, etc. Recognition of the nominative cases of these names depends more upon botanical familiarity with the genera than upon a knowledge of Latin. Fortunately, it is usually safe to guess that generic names with genitive endings in "-ii" have nominative endings in "-ium" instead of "-ius."

The difficulties caused by inflecting generic names could all be avoided easily by using the nominative singular case in some way like one of the following examples: (a) *Alternaria rugosa*: *habitatio-Lycopersicum*. (b) *Rosa*, *Triticum et Syringa ferunt Alternaria tenuis*. (c) *Hab. Solanum; in foliis; ad caules vivos*.

Since clearness is an important literary law, many readers of Latin descriptions are not taxonomists, and there should be response to the need of practical taxonomy and mycology for the applied sciences, it is hoped that the next botanical congress will discourage the inflection of generic names in subsequent descriptions.

#### EXPLANATION OF THE TABULATION

*Column 1* contains the generic names of the plants on which the species of *Alternaria* and *Macrosporium* occur. The generic names given in Saccardo's "Sylloge Fungorum" are translated. Such old names as *Lappa* and *Negundo* are retained because they are used in the descriptions cited. Some common names are given because the descriptions lack generic names.

*Column 2* contains the names of the families. Because species of *Alternaria* have ranges of food plants wider than present knowledge shows, old conceptions of some families are used. For example, Rosaceae includes *Prunus* and Saxifragaceae includes *Ribes*. Thus, they suggest more genera as food plants than the names Drupaceae and Grossulariaceae would do.

Columns 1 and 2 serve as a convenient index to the plants on which the fungi occur. Because the spore sizes of the species vary widely, it is wise to read the whole lists of the family and generic names, and later eliminate those too unlike the species being classified. Many other plants were described by Young (33) as being hosts under laboratory and greenhouse conditions.

*Column 3* gives the lengths of the spores in microns. Many of these measurements include the spore beaks. While spore sizes constitute a fundamental basis for separating species, the ranges in spore sizes have been described so incompletely that strong consideration must be given to food plants in classifying these fungi.

*Column 4* gives the widths of the spores in microns.

*Column 5* contains references to the descriptions of the species. "A" means *Alternaria* and "M" means *Macrosporium*. For example, 4-2A means species of *Alternaria* number 2 in volume 4 of Saccardo's "Sylloge Fungorum"; 16-4M means species of *Macrosporium* number 4 in volume 16. Numbers in parenthesis refer to "Literature Cited." P.F. means Physiological Form of *Alternaria tenuis* as considered in citation 33. Although the spores in culture were small, recent study decides that P.F. 7 was probably *A. crassa* and P.F. 15 was probably *A. Solani*.

(1)	(2)	(3)	(4)	(5)
<i>Dianthus</i>	Caryophyllaceae	8-90	5-25	(10)
<i>Brassica</i>	Cruciferae	8-59	5-19	4-2A (10)
<i>Solanum</i>	Solanaceae	10-22	7-12	11-12M
<i>Amygdalus</i>	Rosaceae	10-25	5-12	4-60M
<i>Citrus</i>	Rutaceae	10-40	8-25	(19)
<i>Setaria</i> (seed)	Gramineae	10-40	7-18	4-1A (3 <sup>3</sup> , 34) P.F. 5
<i>Citrus</i>	Rutaceae	10-40	8-25	18-3A
<i>Zea</i>	Gramineae	10-60	8-20	4-62M (32, 34)
<i>Citrus</i>	Rutaceae	10-47	5-15	16-1M
<i>Brassica</i>	Cruciferae	10-65	5-14	14-1A (33, 34)
Wood	—	11-57	5-21	4-1A (10)
<i>Avena</i>	Gramineae	11-70	7-14	16-4M (33, 34)
<i>Valerianella</i>	Valerianaceae	12-18	10-15	10-15M
<i>Theobroma</i>	Sterculiaceae	12-36	12-18	22-4M
<i>Salvia</i>	Labiatae	12-40	8-12	4-4A
<i>Vitis</i>	Vitaceae	12-24	6-9	4-59M
<i>Suaeda</i>	Chenopodiaceae	12-24	10-12	10-14M
<i>Cucumis</i> (fruit)	Cucurbitaceae	12-54	7-14	4-52M (33, 34)
<i>Cucurbita</i> (fruit)	Cucurbitaceae	12-54	7-14	4-52M (33, 34)
<i>Sambucus</i>	Caprifoliaceae	12-70	5-15	11-14M
<i>Iris</i>	Iridaceae	13-106	5-33	(10)A
Bird Nest	—	13-20	—	4-79M
<i>Solanum</i>	Solanaceae	13-57	3-19	(10)
<i>Brassica</i>	Cruciferae	13.4-70	6.5-14	(15)A
<i>Cucurbita</i>	Cucurbitaceae	13.5-47.5	9.5-17.5	(23)M
<i>Iris</i>	Iridaceae	14-35	8-20	4-75M (33, 34)
<i>Lycopersicum</i> , et al.	Solanaceae	14-60	7-20	(33, 34)A
<i>Lycopersicum</i>	Solanaceae	14-56	11-14	14-3A (33, 34)
<i>Abutilon</i>	Malvaceae	14-54	8-18	10-2A (33, 34)
<i>Capsicum</i> (leaf spot)	Solanaceae	14-70	8-15	4-32M (33, 34)
<i>Triticum</i> (seeds)	Gramineae	14-50	7-14	4-1A (33, 34) P.F. 1
<i>Triticum</i> (seeds)	Gramineae	14-33	7-18	4-1A (33, 34) P.F. 2
<i>Raphanus</i> (leaf spot)	Cruciferae	14-40	7-14	4-1A (33, 34) P.F. 6
<i>Datura</i> (leaf spot)	Solanaceae	14-40	7-18	(21, 33, 34) P.F. 7
<i>Asparagus</i> (stems)	Liliaceae	14-35	8-10	4-1A (33, 34) P.F. 10
<i>Syringa</i> (leaf spot)	Oleaceae	14-50	7-18	4-1A (33, 34) P.F. 13
<i>Symphoricarpos</i> (fruit)	Caprifoliaceae	15-35	7-18	4-1A (33, 34) P.F. 9
<i>Rosa</i> (buds)	Rosaceae	15-36	8-15	4-1A (33, 34) P.F. 11
<i>Datura</i>	Solanaceae	15-105	3-28	(10)A (21)A
<i>Citrus</i>	Rutaceae	15-25	1.7-2	18-1A
Paper	—	15-25	—	4-80M
<i>Asler</i>	Compositae	15-40	12-18	11-13M
<i>Nicotiana</i>	Solanaceae	15-25	10-12	(28)M
<i>Pisum</i>	Leguminosae	15-66	9-21	(11)A
<i>Zea</i>	Gramineae	15-72	9-20	4-62M
<i>Lappa</i>	Compositae	15-75	—	4-3M

(1)	(2)	(3)	(4)	(5)
<i>Allium</i>	Liliaceae	15-75		4-3M
<i>Beta</i>	Chenopodiaceae	15-75		4-3M
<i>Phytolacca</i>	Phytolaccaceae	15-75		4-3M
<i>Lactuca</i>	Compositae	15-75		4-3M
<i>Festuca</i>	Gramineae	15-93	6-18	16-3M
<i>Stipa</i>	Gramineae	16-18	14	(25)M
<i>Cellulose</i>	—	16-38	6-12	(9)A
<i>Aesculus</i>	Hippocastanaceae	16-40	8-27	10-9M
<i>Pyrus</i>	Rosaceae	16-60	9-13	(24)A
<i>Allium</i>	Liliaceae	16-70	10-20	4-69M (33, 34)
<i>Ribes</i>	Saxifragaceae	17-83	7-19	22-3A
<i>Brassica</i>	Cruciferae	17.5	12	14-6M
<i>Salix</i>	Salicaceae	18-20.5	7-9.5	(7)M
Many hosts	—	18-28	9-12	4-1M
<i>Citrus</i>	Rutaceae	18-28	9-12	4-1M
<i>Capsicum</i>	Solanaceae	18-28	9-12	4-1M
<i>Cassia</i>	Leguminosae	18-28	9-12	4-1M
<i>Syringa</i>	Oleaceae	18-28	9-12	4-1M
<i>Nicotiana</i>	Solanaceae	18-28	9-12	4-1M
<i>Asparagus</i>	Liliaceae	18-28	9-12	4-1M
<i>Prunus</i>	Rosaceae	18-28	9-12	4-1M
<i>Platanus</i>	Platanaceae	18-28	9-12	4-1M
<i>Castanea</i>	Fagaceae	18-28	9-12	4-1M
<i>Platanus</i>	Platanaceae	18-28	9-12	4-1M
<i>Alnus</i>	Betulaceae	(18-28)	(9-12)	(32)M
<i>Beta</i>	Chenopodiaceae	18-28	9-12	4-1M
<i>Chenopodium</i>	Chenopodiaceae	18-28	9-12	4-1M
<i>Coffea</i>	Rubiaceae	(18-28)	(9-12)	(32)M
<i>Sterculia</i>	Sterculiaceae	18-28	9-12	4-1M
<i>Rhus</i>	Anacardiaceae	18-28	9-12	4-1M
<i>Yucca</i>	Liliaceae	18-28	9-12	4-1M
<i>Helianthus</i>	Compositae	18-28	9-12	4-1M
<i>Phytolacca</i>	Phytolaccaceae	18-28	9-12	4-1M
<i>Solanum Melongena</i> (fruit)	Solanaceae	18-58	8-18	14-3A (33, 34)
<i>Catalpa</i> (leaf spot)	Bignoniaceae	18-54	10-27	4-42M (33, 34)
<i>Phaseolus</i> (pod)	Leguminosae	18-50	9-14	4-1A (33, 34) P.F. 8
<i>Pyrus</i> (fruit)	Rosaceae	18-40	11-18	4-1A (33, 34) P.F. 14
<i>Viburnum</i> (leaf)	Caprifoliaceae	18-36	8-14	4-1A (33, 34) P.F. 16
<i>Capsicum</i> (fruit)	Solanaceae	18-60	8-14	14-3A (33, 34)
<i>Prunus</i>	Rosaceae	19	10	18-10M
<i>Onobrychis</i>	Leguminosae	19-86	9.5-17	(23)A
<i>Heracleum</i>	Umbelliferae	20	9	14-6M
<i>Wood</i>	—	20	12	11-2A
<i>Lotus</i>	Leguminosae	20-28	16-19	14-12M
<i>Panicum</i>	Gramineae	20-30	10-12	14-21M
<i>Lactuca</i>	Compositae	20-30	10-15	4-19M
<i>Eucalyptus</i>	Myrtaceae	20-30	12-14	18-7M
<i>Ricinus</i>	Euphorbiaceae	20-30	12-14	4-23M
<i>Galeobdolon</i>	Labiatae	20-30	12-18	10-19M
<i>Pelargonium</i>	Geraniaceae	20-30	18-22	11-3M
<i>Deinacanthos</i>	Bromeliaceae	20-30	10-15	(26)
<i>Quercus</i>	Fagaceae	20-30	20	4-45M
<i>Cucurbita</i>	Cucurbitaceae	20-35		4-52M
<i>Juncus</i>	Juncaceae	20-35	5.5-14	14-4A
<i>Wood</i>	—	20-36		4-36M

(1)	(2)	(3)	(4)	(5)
<i>Juglans</i>	Juglandaceae	20-43	10-23	22-6A
<i>Kentia</i> (leaf)	Palmaceae	20-50	10-18	4-1A (33, 34) P.F. 4
<i>Ligustrum</i>	Oleaceae	20-54	10-15	4-1A (33, 34) P.F. 12
<i>Lycopersicum</i>	Solanaceae	20-60	9-14	4-31M (33, 34) P.F. 15
<i>Pelargonium</i>	Geraniaceae	20-57	8.5-17	14-4M
<i>Polytrichum</i>	Polytrichaceae	20-60	7.5-15	10-26M
<i>Vitis</i>	Vitaceae	20-64	8-15	14-11M
<i>Solanum</i>	Solanaceae	20-70	10-20	10-21M
<i>Bigelovia</i>	Compositae	20-70	15-22	10-4M
Food	—	22	12	4-81M
<i>Rubus</i>	Rosaceae	22-25	9	10-5M
<i>Pyrus</i> (fruit)	Rosaceae	22-62	9-15	22-1M (33, 34)
<i>Hibiscus</i>	Malvaceae	22-26	10-12	10-10M
<i>Saponaria</i> (leaf spot)	Caryophyllaceae	22-80	7-14	4-28M (33, 34)
<i>Dictamnus</i>	Rutaceae	23-40	8-12	22-2M
<i>Sonchus</i>	Compositae	23-102	6-31	(10)A
<i>Celosia</i>	Amaranthaceae	24-26	14-18	18-4M
<i>Thea</i>	Ternstroemiaceae	24-28	10	22-5M
<i>Trifolium</i>	Leguminosae	24-28	12-18	10-16M
<i>Sphaeropsis</i>	Sphaerioidaceae	24-38	15-20	11-17M
<i>Polypodium</i>	Polypodiaceae	24-70	10-19	(13)A
<i>Lagenaria</i>	Cucurbitaceae	24-40	10-20	4-50M
Herbs	—	24-40	6-15	4-33M
<i>Brassica</i>	Cruciferae	25	7.5	14-1A
<i>Crataegus</i>	Rosaceae	25-33	16-20	4-47M
<i>Collaea</i>	Leguminosae?	25-35	10-12	(26)M
<i>Citrus</i>	Rutaceae	25-36	18-25	4-41M
<i>Medicago</i>	Leguminosae	25-35	16-18	18-1M
<i>Urtica</i>	Urticaceae	25-85	5-5.5	14-16M
<i>Vitis</i>	Vitaceae	25-45	10-12.5	14-2A
<i>Carex</i>	Cyperaceae	25-50		4-68M
<i>Melilotus</i>	Leguminosae	25-50	3-5	4-29M
<i>Negundo</i>	Aceraceae	25-50	10-12	14-10M
<i>Clematis</i>	Ranunculaceae	26-40	13	14-1M
<i>Symplocarpus</i>	Araceae	26-50	20-30	(31)M
<i>Dianthus</i>	Caryophyllaceae	26-100	13-38	(8)A
<i>Dianthus</i>	Caryophyllaceae	26-123	10-20	22-2A
<i>Cirsium</i>	Compositae	27-38	13-15.5	22-6M
<i>Catalpa</i>	Bignoniaceae	27-54	15-27	4-42M
<i>Secalis</i>	Gramineae	27-60	9-15	18-16M
<i>Datisca</i>	Datisceae	28	11-12	4-22M
<i>Pyrus</i>	Rosaceae	28	12	22-1M
<i>Vitis</i>	Vitaceae	28-30	15	11-4M
<i>Cucumis</i>	Cucurbitaceae	28-105	8-31	4-2A (10)
<i>Lotus</i>	Leguminosae	28-30	18-20	18-6M
<i>Ustilago</i>	Ustilaginaceae	29-67	8-12	10-27M
<i>Brassica</i>	Cruciferae	29-108	8-25	(1)A
Herbs	—	30	10	10-12M
<i>Cassia</i>	Leguminosae	30	12-16	4-58M
<i>Glodium</i>	Leguminosae	30	15	4-55M
<i>Gynerium</i>	Gramineae	30	15	4-65M
<i>Iris</i>	Iridaceae	30-35	15-20	4-75M
<i>Hedera</i>	Araliaceae	30-35	18	4-6M
<i>Euphorbia</i>	Euphorbiaceae	30-35	18	4-6M
<i>Evonymus</i>	Celastraceae	30-35	18	4-6M

(1)	(2)	(3)	(4)	(5)
Many hosts		30-36	14-15	4-1A
<i>Cassia</i>	Leguminosae	30-72	16-20	10-3M
<i>Allium</i>	Liliaceae	30-40	12-15	22-9M
<i>Quercus</i>	Fagaceae	30-40	18	14-18M
<i>Colutea</i>	Leguminosae	30-45	12-18	4-56M
<i>Arbutus</i>	Ericaceae	30-45	23-32	11-1A
<i>Aecidium</i>	Pucciniaceae	30-50	10-12	10-28M
<i>Cassia</i>	Leguminosae	30-50	10-15	10-8M
<i>Laminaria</i>	Laminariaceae	30-50	12-18	(30)A
<i>Puccinia</i>	Pucciniaceae	30-50	12-15	14-22M
<i>Dianthus</i>	Caryophyllaceae	30-70	10-16	11-5M
<i>Petroselinum</i>	Umbelliferae	30-76	12-20	(18)M
<i>Asphodelus</i>	Liliaceae	30-110	18-30	14-19M
<i>Cucumis</i>	Cucurbitaceae	30-110	15-25	(28)M
<i>Dianthus</i>	Caryophyllaceae	31-75	18-36	14-13M
<i>Musa</i>	Musaceae	32-40	18-24	4-74M
<i>Amaranthus</i>	Amaranthaceae	32-64		14-15M
<i>Hypoxylon</i>	Xylariaceae	33-34		4-78M
<i>Pelargonium</i>	Geraniaceae	33-51	9-18	18-3M
<i>Malva</i>	Malvaceae	33-54	9-14	10-2A
<i>Ricinus</i>	Euphorbiaceae	34-47	10-13	(17)M
<i>Daucus</i>	Umbelliferae	34-51	10-22	(14)A
<i>Papaver</i>	Papaveraceae	34-51	10-12	(17)M
<i>Ruta</i>	Rutaceae	35-40	20	4-53M
<i>Solanum</i>	Solanaceae	35-119	3-21	(10)A
<i>Pelvetia</i>	Fucaceae	35-45	11-12	(29)M
<i>Pyrus</i>	Rosaceae	35-50	9-12	18-8M
<i>Phytolacca</i>	Phytolaccaceae	35-50	16-21	(6)
<i>Apium</i>	Umbelliferae	35-50	18	4-14M
<i>Lycopersicum</i>	Solanaceae	35-66	16-20	(28)A
<i>Laminaria</i>	Laminariaceae	35-70	16-25	(30)M
<i>Allium</i>	Liliaceae	35-60	10-15	4-71M
<i>Linaria</i>	Scrophulariaceae	35-60	12-20	(5)M
<i>Phytolacca</i>	Phytolaccaceae	35-100	15-18	4-26M
<i>Magnolia</i>	Magnoliaceae	35-100	18-22	4-48M
<i>Gossypium</i>	Malvaceae	36-40	14-16	4-11M
<i>Gossypium</i>	Malvaceae	36-50	18-22	(28)M
<i>Arnica</i>	Compositae	36-40	30	22-7M
<i>Goniolimon</i>	Plumbaginaceae	36-48	14-20	4-30M
<i>Mulgedium</i>	Compositae	36-51	24-30	14-14M
<i>Citrus</i>	Rutaceae	37-75	17-20	18-11M
<i>Ricinus</i>	Euphorbiaceae	39-47	10-13	(17)M
<i>Scolopendrium</i>	Polypodiaceae	40	15	10-25M
<i>Hibiscus</i>	Malvaceae	40	16-18	4-13M
<i>Juncus</i>	Juncaceae	40-45	14-16	11-16M
<i>Ilex</i>	Aquifoliaceae	40-50	8-10	22-3M
<i>Ficus</i>	Moraceae	40-50	10-16	14-17M
<i>Lactuca</i>	Compositae	40-50	15-20	4-18M
<i>Nicotiana</i>	Solanaceae	40-100	15-20	11-7M
<i>Malva</i>	Malvaceae	40-100	12-15	14-5M
<i>Allium</i>	Liliaceae	40-50	20-25	10-22M
<i>Zea</i>	Gramineae	40-50	18	4-61M
<i>Calamagrostis</i>	Gramineae	40-50	20-25	4-64M
<i>Viola</i>	Violaceae	40-60	10-17	16-1A
<i>Vitis</i>	Vitaceae	40-60	12-14	10-5A
<i>Abies</i>	Pinaceae	40-60	30-38	4-3A
<i>Lycopersicum</i>	Solanaceae	40-80	11-14	14-3A
<i>Cucurbita</i>	Cucurbitaceae	40-80	20-25	4-4M
<i>Sorghum</i>	Gramineae	40-85	12-16	18-15M

(1)	(2)	(3)	(4)	(5)
<i>Viola</i>	Violaceae	40-90	16	14-2M
<i>Malva</i>	Malvaceae	40-100	12-15	14-5M
<i>Iris</i>	Iridaceae	40-120	20-25	11-15M
<i>Prunus</i>	Rosaceae	41-62	14-15	18-9M
<i>Grossularia</i>	Saxifragaceae	42-50	8-12	22-4A
<i>Allium</i>	Liliaceae	42-48	10-16	4-69M
<i>Dianthus</i>	Caryophyllaceae	42-53	15-20	18-2M
<i>Cucumis</i>	Cucurbitaceae	44-62	11-15	18-12M
<i>Phaseolus</i>	Leguminosae	45	10-12	11-1M
<i>Panax</i>	Araliaceae	45-65	15-20	(28)A
<i>Baptisia</i>	Leguminosae	45	16	4-43M
<i>Silene</i>	Caryophyllaceae	45-95	22-38	(4)M
<i>Ficus</i>	Moraceae	46-70	12-14.5	18-4A
<i>Nelumbium</i>	Nymphaeaceae	47-65	10-15	11-2M
<i>Hedera</i>	Araliaceae	48-56	11-13	18-13M
<i>Jatropha</i>	Euphorbiaceae	50	12-13	4-5M
<i>Ilex</i>	Aquifoliaceae	50	12-13	4-5M
<i>Pisum</i>	Leguminosae	50	12-13	4-5M
<i>Cassia</i>	Leguminosae	50	15	4-57M
<i>Pinus</i>	Pinaceae	50	15	4-34M
Soil	—	50	16	18-6A
<i>Silene</i>	Caryophyllaceae	50	23	11-11M
<i>Sagittaria</i>	Alismaceae	50-60		4-4M
<i>Brassica</i>	Cruciferae	50-60	12-14	4-8M
<i>Canna</i>	Cannaceae	50-60	14-20	4-73M
<i>Boucerosia</i>	Asclepiadaceae	50-60	15	4-21M
<i>Ammi</i>	Umbelliferae	50-60	15-18	4-15M
<i>Prunus</i>	Rosaceae	50-60	17-20	22-5A
<i>Ferula</i>	Umbelliferae	40-65	9-10	(25)M
<i>Calycanthus</i>	Calycanthaceae	50-70	11-13	10-6M
<i>Asparagus</i>	Liliaceae	50-70	15	4-77M
<i>Phytolacca</i>	Phytolaccaceae	50-70	20-25	4-24M
<i>Lactuca</i>	Compositae	50-70	20-25	4-24M
<i>Papaver</i>	Papaveraceae	50-72	18-30	(3)M
<i>Saponaria</i>	Caryophyllaceae	50-80		4-28M
<i>Nicotiana</i>	Solanaceae	50-90	10-15	11-6M
<i>Abutilon</i>	Malvaceae	50-90	10-15	10-20M
<i>Pyrus</i>	Rosaceae	50-100	10-15	4-46M
<i>Prunus</i>	Rosaceae	52-64	13-18	18-5A
<i>Papaver</i>	Papaveraceae	52-80	14-20	10-3A
<i>Heracleum</i>	Umbelliferae	55	15	14-7M
<i>Papaver</i>	Papaveraceae	55-100	25-35	(12)M
<i>Daucus</i>	Umbelliferae	55-180	12-14	10-17M
<i>Cucumis</i>	Cucurbitaceae	55-110	15-25	14-9M
<i>Camellia</i>	Ternstroemiaceae	56-100	15-25	10-7M
<i>Malva</i>	Malvaceae	58	17	4-10M
<i>Sparganium</i>	Sparganiaceae	60	11-12	22-12M
Bark		60	18-20	4-37M
<i>Crithmum</i>	Umbelliferae	60	23	11-10M
<i>Phaseolus</i>	Leguminosae	60-62	15	14-1A
<i>Cucurbita</i>	Cucurbitaceae	60-68	8-9	10-1A
<i>Asclepias</i>	Asclepiadaceae	60-70	10	4-20M
<i>Datura</i>	Solanaceae	60-70	10	4-32M
<i>Solanum</i>	Solanaceae	60-70	10	4-32M
<i>Citrus</i>	Rutaceae	60-70	14-18	4-2A
<i>Agave</i>	Amarylloidaceae	60-70	14-17	22-10M
<i>Bambusa</i>	Gramineae	60-70	22	10-23M
<i>Brassica</i>	Cruciferae	60-80	14-18	4-2A
<i>Hibiscus</i>	Malvaceae	60-80	16-20	4-12M

(1)	(2)	(3)	(4)	(5)
<i>Zea</i>	Gramineae	60-80	20	4-63M
<i>Dianthus</i>	Caryophyllaceae	60-80	40	4-27M
<i>Quercus</i>	Fagaceae	64-85	15-17	10-1M
Palms	Palmaceae	65-70	30-35	10-6A
<i>Avena</i>	Gramineae	70	10-12	16-4M
<i>Dahlia</i>	Compositae	70	17	4-17M
<i>Sonchus</i>	Compositae	70	11	(27)A
<i>Citrus</i>	Rutaceae	60-75	15-20	16-2M
<i>Trichosanthes</i>	Cucurbitaceae	80-95	13-15	18-1A
<i>Spinacia</i>	Chenopodiaceae	80-120	12-14	16-2A
<i>Cruciferae</i>	Cruciferae	90-350	13-42	(1)A
<i>Triticum</i>	Gramineae	95-110	18-20	14-1A
<i>Cucumis</i>	Cucurbitaceae	100	14-20	22-1A
<i>Lycopersicum</i>	Solanaceae	100-120	20-22	4-54M
<i>Solanum</i>	Solanaceae	100-140	15-18	4-31M
<i>Cynara</i>	Compositae	100-140	19-20	10-11M
<i>Dianthus</i>	Caryophyllaceae	100-160	16-25	18-2A
<i>Solanum</i>	Solanaceae	104-184	14-18	(22)A
<i>Allium</i>	Liliaceae	105-320	12-24	(16)A
<i>Solanum</i>	Solanaceae	110-116		11-9M
<i>Brassica</i>	Cruciferae	115-240	20-25	14-3M
<i>Brassica</i>	Cruciferae	120-140	20-25	4-2A
<i>Solanum</i>	Solanaceae	120-296	12-20	(22)A
<i>Carex</i>	Cyperaceae	120-150		14-20M
<i>Datura</i>	Solanaceae	128-448	16-40	(21)A
<i>Solanum</i>	Solanaceae	145-370	16-18	(28)A
<i>Allium</i>	Liliaceae	150-180	15-20	4-70M
<i>Nasturtium</i>	Cruciferae	200-225	21-26	4-9M
<i>Datura</i>	Solanaceae	200-290	18-20	11-8M

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AGRICULTURAL EXPERIMENT STATION,  
BOZEMAN, MONTANA

## NOTES AND BRIEF ARTICLES

Dr. G. R. Bisby, Pathologist in the Manitoba Agricultural Experiment Station, Winnipeg, Canada, recently stopped at The New York Botanical Garden on his way to Europe where he will spend a year continuing his mycological studies in various European herbaria.

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News of the death of Professor F. S. Earle at his home in Heradura, Cuba, on January 31, 1929, reached us in February. Professor Earle is well known to mycologists in every part of the world and has been Associate Editor of MYCOLOGIA from its inception. A more detailed account will appear in some later issue of MYCOLOGIA.

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Doctor B. O. Dodge, Pathologist at The New York Botanical Garden, spent January 24th and 25th at Cornell University in conference with members of the staff and graduate students in the Department of Plant Pathology and Genetics. While there he lectured on "Sex in the Fungi and the Production of Fertile Interspecific Hybrids."

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### A NEW MUSHROOM BOOK

The series of G. P. Putnam's Nature Field Books has recently been augmented by an excellent little volume entitled "Common Gilled Mushrooms," by Dr. W. S. Thomas. American literature has in the past been noticeably lacking in books of this type, and especially so when compared with the output of such works in Europe. Dr. Thomas's book fills, therefore, a very definite want, and will be warmly welcomed by all interested in this field of inquiry. To the advanced student, the fine color paintings from the work of Miss Eaton, here brought together for the first time, will prove extremely useful, including as it does 16 plates representing 96 species of mushrooms. A few half tones and some pen and ink drawings are also included. The work on

all of these is of a very high quality and constitutes no inconsiderable part of the value of the volume. To the mycophagist and the mycologist alike the very complete descriptions of 128 species of gilled fungi, with additional notes and comments, often from the writings of Peck, Atkinson, and Kauffman, will go a long way towards settling the question of the identity of the common species of our woods and fields. Probably no one knows, even approximately, how many species of mushrooms any limited region contains, but certainly 128 species is a goodly number, and all of these are to be found in at least our eastern flora. For example, descriptions and illustrations are given of 10 species of *Clitocybe*, 6 species of *Collybia*, and 3 species of *Coprinus*; and when one has learned to know these common species he is on the way to a fairly comprehensive acquaintanceship with these genera. No volume in the nature of a field manual, particularly for the amateur, could include all the species in any region. To attempt such a task would defeat the purposes of such a manual. The author has chosen his species wisely and presented them in a thorough and a pleasing manner.

The novel feature of this volume is the author's attempt to present a scheme whereby one may determine the identity of a mushroom with the least possible effort. Approximately one-third of this volume of some 300 pages is devoted to this scheme. The fear is that the very magnitude and the *apparent* complexity of this part of the work will deter the beginner from attempting to use it. When one learns the scheme, however, it is really not complex, and the more one will work with it the easier it will become. Perhaps the author has not sufficiently emphasized, in his explanation of this synopsis, the best course to pursue. He is so familiar with the scheme from years of association with it that it probably does not occur to him that there can be any element of complexity or doubt as to how to proceed. This statement is made in spite of the three examples given by the author to illustrate the process. If the reviewer understands the way this synopsis is supposed to work, the first question one must ask himself is: "What is the outstanding feature of the plants at hand?" It may be the pure white color of the entire plant, the strikingly violaceous color of gills or pileus, the lack of a stem,

the place of growth, etc. All of the species that possess this character are grouped into a synoptic outline in such a way that, by the aid of a few other characters, it will often be possible to identify the plant with very little effort. However, everything depends on selecting the outstanding character, or any one of several in some cases. Many species, however, do not possess what, to the amateur, might be considered outstanding characters; in other words, many species "all look alike" to the untrained eye. It is these that will be troublesome to identify. This type of key does have the advantage that in case of species with more than one prominent character one can attempt its identification by more than one route, and if the result is the same in all cases the identity is assured. Perhaps it is unfortunate, however, that a key of the usual sort was not included for the benefit of the more advanced student, at least. However, four pages of line drawings representing typical specimens of all the genera will be found helpful in this respect.

A chapter on "Mushrooms as Food" reproduces Peck's article in the 48th Report of the New York State Museum, and two additional short chapters are devoted to recipes for cooking mushrooms.

The names used are in all cases the old established ones by which they have been so long known in this country. This is a commendable feature of the book. The press work is unusually well done, and the pages are practically if not entirely free from typographical errors. Finally, the book is very attractively bound and will be a distinct addition to any book shelf. Every one interested in gill fungi should have a copy. There is no question but that it will be the most popular mushroom book yet issued in this country, and Dr. Thomas and the Putnam Company should have the best thanks of American mycologists and mycophagists for making it available in such excellent form.

L. O. OVERHOLTS.

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#### A NEW RUST HANDBOOK

*Handbook of the North American Uredinales including Citations and Synonymy.* By ELAM BARTHOLOMEW. 1928.

In this Handbook of 193 pages the author presents a catalog of the species of the North American Uredinales, with synonymy

and citations. According to a summary in the "Foreword" there are 1,240 species<sup>1</sup> and 3,505 synonyms. The area included embraces continental North America, Greenland, and the West Indies. The book was printed in Stockton, Kansas, the home of the author. The arrangement and the choice of type is good.

This handbook is just what it purports to be, *i.e.*, a list of the species of rusts. There are no notes and no references to hosts. The family and generic arrangement is largely based on Arthur's treatment in Volume 7 of the North American Flora with the notable exceptions that *Puccinia* replaces *Dicaeoma*, *Allodus*, *Bullaria*, and *Micropuccinia*, and *Uromyces* replaces *Nigredo*, *Pucciniola*, *Klebahnna*, and *Teleutospora*. The arrangement of species under a genus is alphabetical. After every species which is included in the North American Flora is cited the number of the page or pages where the species is described or referred to in the Flora. This handbook, therefore, serves as an index to Volume 7 of the Flora.

Bartholomew states that "several new combinations in authorship have been made where the shifting in nomenclature seems to warrant them." One cannot refrain from expressing a regret that these new combinations are not specifically indicated. As it is, there is nothing to indicate a transfer except that the author has placed his name after the parentheses and no citation follows. To determine just what changes have been made in this work would require some very close observations. This is particularly true here because the citation follows not on the same line with the specific name but on the next line. This increases very materially the difficulty. The second line must always be examined to determine whether a citation is or is not given.

In these days of shifting ideas as to nomenclature it is always a matter of interest to examine a catalog of names to discover what system, if any, is being followed. Some unusual situations are always likely to be found. In this work the author evidently has no objections to specific names because they are founded on aecial stages. For example he accepts *Puccinia Asterum* as the

<sup>1</sup> According to my count, Arthur describes 1,218 species in Vol. 7 of the North American Flora.

name for the *Carex-Aster* rust and *Puccinia urticata* for the *Carex-Urtica* rust. Many other examples could be cited. An interesting case is where a new combination *Puccinia Sommerfeldtii* (Johans.) Barth. is made, based on *Aecidium Sommerfeldtii* Johans. On the other hand *Puccinia graminis* Persoon is maintained although on the basis of the three names just referred to the name would be *Puccinia poculiformis* (Jacq.) Wettst., based on the aecial stage *Lycoperdon poculiforme* Jacq., which has priority over the specific name *graminis*. This is apparently a situation where priority is deliberately disregarded and a later name is conserved. One cannot disagree with the evident motive for such a procedure, since a feeling of fitness may make a stronger appeal than the rigid application of a rule. It does seem reasonable, however, that a definite note of explanation of procedure should be offered, for otherwise the use that is made of the names that the past has bequeathed to us is not clear. In looking down the list of synonyms it is surely right to expect a uniform treatment unless attention is clearly called to the exception. The reviewer wishes to point out that these remarks are not to be regarded as a criticism of this Handbook alone, but rather as a commentary on a general condition that obtains in mycological nomenclature, to which attention must be given, if we are ever to come to an acceptable and workable system.

There is one feature, however, for which the author of this Handbook must be adversely criticized. It often happens, as everyone knows, that the oldest specific name cannot be used because it is preoccupied in the genus to which it is being referred. In that case a later name is taken up or, if none exists, a new one must be proposed. Always the reason for not taking up a name must be distinctly given or otherwise an apparently acceptable name is disregarded without cause. A single instance will illustrate the point. On p. 160 *Puccinia Sarcobati* (Peck) Bethel, a combination made in 1921, is accepted as a valid name founded on *Aecidium Sarcobati* Peck, 1881. The first synonym listed is *Aecidium biforme* Peck, 1875. If this were followed with the statement "Not *Puccinia biformis* Lagerh. 1896" the matter would be clear. As it stands, one is uncertain why the prior name is rejected. Such instances are altogether too numerous

and throw too much burden on the user to comprehend just what the situation is.

This is the first attempt to bring together under one cover a complete list of the North American rusts and mycologists both at home and abroad are under obligations to the author for this work.—FRANK D. KERN.

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PROPOSED AMENDMENTS TO THE INTERNATIONAL RULES  
OF NOMENCLATURE

1. Art. 19. Amend to read:

Botanical nomenclature begins for all groups of plants (recent and fossil) at 1753 (Linnaeus, *Species Plantarum*, ed. 1).

It is agreed to associate genera, the names of which appear in Linnaeus's *Species Plantarum*, ed. 1, with the descriptions given of them in the *Genera Plantarum*, ed. 5 (1754).

2. Art. 49 bis. Omit *in toto*.

3. Add the following to the list of Nomina Conservanda:

<i>Fam.</i>	<i>Nom. conserv.</i>	<i>Nom. rejic.</i>	<i>Typus</i>
Pucciniaceae	<i>Uromyces</i> (Link,	<i>Caeomurus</i> (Link	<i>Uromyces</i>
	Ges. nat.	Ges. Nat.	<i>appendi-</i>
	Freunde Berlin	Freunde Berlin	<i>culatus</i> (Link)
	Mag. VII (1815)	Mag. III (1809)	Unger, on
	p. 28) Unger,	p. 7) S. F. Gray	<i>Phaseolus</i>
	Exanth. Pfl.	Nat. Arr. Brit.	<i>vulgaris</i> .
	(1833) p. 277.	Pl. I (1821)	
		p. 541.	
		<i>Pucciniola</i>	
		Marchand,	
		Bijdr. Nat. Wet.	
		IV (1829) p. 47.	

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REMARKS ON THE AMENDMENTS

1. The effect of the amendment is to make the Rules apply to all plants alike. Any date later than 1753 can affect very few

names in any one group of plants, and such names can be treated in the list of nomina conservanda.

2. This article is founded upon a misunderstanding of the practical difficulties in the way of recognizing the "perfect" and "imperfect" states in many instances. It also fails to recognize the relative taxonomic importance of names when applied to the different states. The old idea that species and genera can not be distinguished by the urediniospores is not only untrue, but as a matter of fact they are the chief, and often the only means for such distinctions in some groups, *e.g.*, in the genera *Uredinopsis*, *Hyalopsora* and *Milesia*, and in species among the grass and sedge rusts (see key to same in N. Am. Flora 7: 269-274). The application of the rule is not likely to meet with approval from those who are best informed. The result aimed at can better be attained by means of nomina conservanda.

3. *Uromyces* is a well known generic name, and is as acceptable in every way as the less known earlier names.

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#### TO BOTANISTS INTERESTED IN THE TAXONOMY OF THE LOWER PLANTS

The International Rules of Nomenclature adopted at Vienna in 1905 applied only to phanerogams and ferns. At the Brussels Congress in 1910 a certain amount of recognition was accorded to the lower plants. The Ithaca Congress in 1926 strengthened the committees to look after and report on nomenclature at the Congress to be held in Cambridge, England, August, 1930. The writer attended these Congresses as a member of the committee on cryptogamic nomenclature, and intends to be present at the next Congress.

Firmly believing that the naming of plants of all gradations should be guided by essentially the same rules, I propose to present 3 motions to amend the Rules, as shown above. I am distributing these propositions as widely as possible to ascertain how much support they are likely to receive from other taxonomists. As these motions must be presented in printed form to the chairman, Dr. John Briquet, Geneva, Switzerland, by

March 31, 1929, I will be pleased to learn as early as possible, whether you are willing to support any one or all of the motions by your signature. If you prefer a modified form, please so indicate.

The matter presented above was sent out in mimeograph form early in March to a large number of botanists, and many replies have been returned. Since it was written, word has been received that the time for reporting to Dr. Briquet has been extended to September. The liberal extension of time will enable European botanists and many others to reply, who may have thought the limited time made it unnecessary.

The Rules as they now stand give the priority date for mosses, rusts, smuts and gasteromycetes as 1801, and for other fungi 1821-32, for desmids 1848, nostocs 1886-93, oedogoniums 1900, leaving bacteria, flagellates, diatoms, and some other groups undecided. These arbitrary exceptions to 1753 as an acceptable date for beginning priority in the majority of plants are open to controversy. The writer will be pleased to learn the opinion of botanists interested in the several classes of plants, and of others as well.

As voting in the Congress is not confined to specified groups, the writer would like to ascertain not only how many favor the proposed changes wholly or in part, but what opposition to their presentation is likely to develop.

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